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Improving Safety through Digitalization

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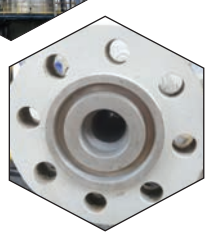

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40 Wall Street, 16th floor, New York, NY 10005, U.S.
Tel: 212-621-4900
Fax: 212-621-4694

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Zeilweg 44, D-60439 Frankfurt am Main, Germany
Tel: 49-69-9573-8296
Fax: 49-69-5700-2484

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BPA WORLDWIDE

Editor's Page

Immersive technologies advance

One of our cover stories this month highlights how augmented reality (AR) is being used in industrial settings to enhance plant safety (Enhancing Plant Safety via Virtual 'On-Site' Visits, pp. 30–34). While AR was already gaining momentum before the pandemic in industrial applications like maintenance and training, the need for distancing imposed by the coronavirus has accelerated the use of many digital technologies, including immersive technologies like AR.

AR, VR, MR and XR

Augmented reality places digital images onto real-world images, so you can, for example, see information about a pump superimposed on top of the actual pump using an AR headset. Virtual reality (VR) on the other hand, takes the user to a completely computer-generated simulation. A combination of these two technologies, AR and VR, is referred to as mixed reality (MR). Collectively, AR, VR and MR are referred to as XR, or extended reality.

In a recent article, Deloitte [*1*] predicts that unit sales in 2021 of VR, AR and MR headsets will double over 2019 levels, and sales of related software and services will follow. And, most of that growth is expected to be due to purchases by corporations and educational institutions. According to the International Data Corp. (IDC) [*2*], worldwide spending on AR and VR is forecast to grow from just over $12 billion in 2020 to $72.8 billion in 2024. The largest commercial-use investments in 2024 are expected to be training ($4.1 billion) and industrial maintenance ($4.1 billion).

In addition to enhancing safety and for training applications, industry may find XR technologies a useful addition to enhance a changing corporate culture that encompasses both remote and on-site workers. In a recent poll of chief human resources officers by PwC [*3*], investing in immersive technologies, such as VR headsets, was identified as an area of potential improvement for a hybrid work situation to better engage employees in meetings and conferences.

Advances in immersive technologies are continuing to evolve. One area, for example, is "haptics." Simply stated, haptic feedback, or "haptics," is a simulated sense of touch. The vibration setting on our mobile phones, and the subtle sensation of clicking a button on a touchscreen are examples. Recent technological advances are enabling the development of more sophisticated haptics that can be used in a variety of ways, such as in wearable devices.

In this issue

In addition to AR, our cover stories this month also discuss the role that data analytics can play in improving process safety (Advanced Analytics for Process Safety, pp. 35–38). Our two features on valves focus on severe service and corrosion considerations (Keeping Valves Corrosion Free, and Specifying Severe-Service Valves for Urea Applications, pp. 39–46). And, some of the latest challenges and opportunities facing petroleum refineries are the topic of our Newsfront (Renewable Feed, New Technology and C2C Strategies Offer Opportunities for Refiners. pp. 12–16). We hope you enjoy reading. ■

Dorothy Lozowski, Editorial Director

1. From virtual to reality: Digital reality headsets in enterprise and education. www2.deloitte.com, December 2020.

2. Worldwide Augmented and Virtual Reality Spending Guide, www.idc.com, November 17 2020.

3. PwC US Pulse Survey, www.pwc.com/us/en/library/chro.html, March 2021.

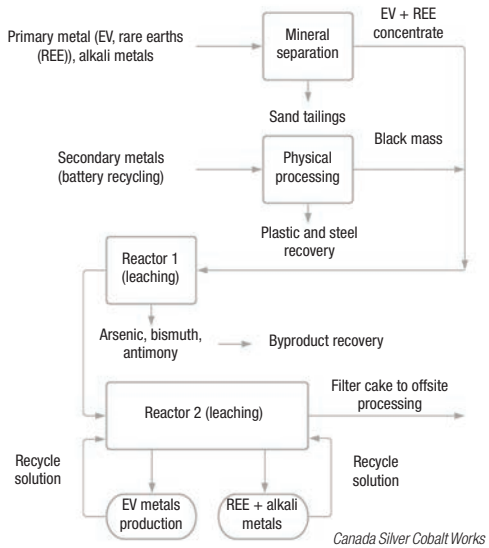
Bespoke battery recycling

A proprietary hydrometallurgical process known as Re-2Ox —originally conceived for the production of high-grade cobalt sulfate from mineral resources — is now showing promise in the field of battery recycling. "We did some preliminary test work and the technology was amenable to batteries. The intent is to process not just primary feed, but also secondary feed, which is all the different battery products, including lithium ion, nickel cadmium and nickel hydride. We take all these secondary feeds and break down the batteries into usable materials," explains Frank Basa, CEO of Canada Silver Cobalt Works Inc. (Coquitlam, B.C., Canada; www.canadasilvercobaltworks.com).

The basis for Re-2Ox is an acid-leaching process that is both zero-discharge and potentially carbon-neutral, adds Basa, noting that the Re-2Ox pilot program being run at SGS Canada's Lakefield location runs on solar and hydroelectric power. The company is planning to continue building out the current pilot program and construct a dedicated pilot plant in northern Ontario, which will become the first hydrometallurgical battery-recycling facility in North America.

What sets the Re-2Ox process apart is its versatility to match a wide variety of secondary battery feedstocks with customized end-product requirements. "Typically, we start with two months of testing to see what builds up in these recycled streams, since the batteries we process are not all consistent," explains Basa. To eliminate process waste, the company tries to ensure that it can make use of all components that are present in the battery feeds they receive, from arsenic to rare-earth metals to organic compounds. "We are currently working with a large recycler that is interested in mainly recovering rare-earths from a largely nickel-hydride-based feed. We have a modified reactor with a special accumulator for rare-earths, which we are recovering as a bulk product to be sent elsewhere for further processing," adds Basa.

Re-2Ox Process Flowsheet



Canada Silver Cobalt Works

Demonstration for a new process to make isobutene

Last month, OMV AG (Vienna, Austria; www.omv.com) commissioned its ISO C4 demonstration isobutene plant at its Burghausen, Germany site. The plant is based on technology developed jointly by OMV and BASF SE (Ludwigshafen, Germany; www.basf.com), and has been producing high-purity (up to 99.9%) isobutene since the end of 2020.

The plant is said to have an "exceptional" energy efficiency — up to 80% of the heating energy required for the new process can be met by thermal discharge from an existing associated facility thanks to a heat-integration approach. This saves 20,000 metric tons of CO_2 emissions per year, the companies say. A worldwide patent application was filed jointly by the two companies, and the process will now be available to third parties, says BASF.

BASF provides the catalyst and reaction concept that intrinsically fulfills all process requirements by OMV. The new unit for the production of high-purity isobutene, which does not need chemical conversion of isobutene, has been integrated into the existing metathesis plant at OMV's Burghausen site. The isobutene produced here complements OMV's existing product portfolio and will be used for manufacturing glues, grease and other chemicals, such as antioxidants, as well as in the production of vitamin C. The plant's production capacity is 60,000 ton/yr.

Investment volume of this large-scale project, including auxiliary facilities, was €64 million. Germany's Federal Ministry of the Environment subsidized €2.8 million toward the ISO C4 plant as part of its environmental innovation program.

Edited by:
Gerald Ondrey

ETHYLENE

Toyo Engineering Corp. (Chiba, Japan; www.toyo-eng.com) has been awarded a contract for a project to construct an ethylene pilot plant, using waste-derived ethanol as raw material. The project is planned by Sumitomo Chemical Co. at its Chiba Works. Sumitomo Chemical has established a cooperative relationship with Sekisui Chemical Co. for the implementation of the technology to manufacture polyolefins using waste as raw material. Sumitomo will begin pilot production of the high-purity ethylene — the raw material for polyolefin — using waste-derived ethanol to be produced by Sekisui Chemical from the fiscal year 2022.

Toyo has worked with Sumitomo Chemical since the basic design of the plant and is currently carrying out the detailed engineering, procurement, and construction (EPC) lump-sum contract, aiming to start demonstration operation of the plant for a short period. The project is slated for completion in 2022.

BIOPLASTIC

Four Finnish companies — Finnfoam Oy (Salo; www.finnfoam.com), Brightplus Oy (Tampere, Suomi; www.brightplus.com), VTT Technical Research Centre of Finland (Espoo; www.vttresearch.com) and Nordic Soya Oy (Uusikaupunki; www.nordicsoya.com) — have developed a process to produce compostable bioplastic from food-and-feed production side streams. The process was developed in the course of a four-year research project that was partly funded

(Continues on p. 6)

by Business Finland. A biopolymer plant will be built in Uusikaupunki, Finland, in which bioplastic production will be piloted on an industrial scale. The new plant is to be operating by the end of 2023.

The four partners have jointly explored the possibilities of using soy molasses — a side stream of soy processing — as a raw material of the future. "The process developed as an outcome of this cooperation project is the first in the world to produce an ecological lactic-acid polymer from the side streams of soy production," says Henri Nieminen, CEO of Finnfoam. "This way, we can offer a sustainable alternative to sugar- and corn-based polylactic acid (PLA)," he says.

Soy molasses, which is not suitable for food, has previously been disposed of by incineration. Producing bioplastic from this residue of soy processing has huge potential as a scalable export product in the circular economy. Globally, residues from soy production could produce around 22 million metric tons (m.t.) of bioplastic per year.

GREEN AMMONIA

Last month, Mitsubishi Heavy Industries, Ltd. (MHI; Tokyo, Japan; www.mhi.com) announced that it has invested in Starfire Energy Inc. (Denver, Colo.; www.starfireenergy.com), a developer of modular chemical plants for the production of green NH_3 and H_2 using a patented catalyst technology. The partnership will be used to advance the development of commercial-scale applications to decarbonize NH_3 production and unlock its potential as a zero-carbon energy carrier. The investment has been executed through Mitsubishi Heavy Industries America, Inc., joining a consortium of investors,

(Continues on p. 7)

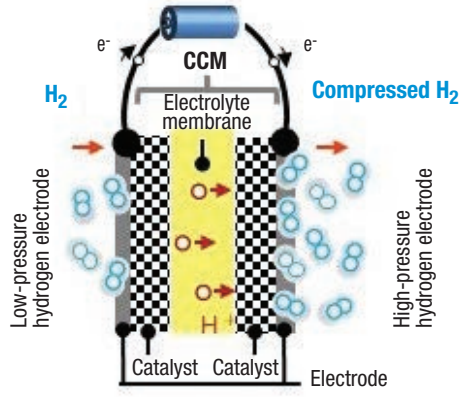
Compressing hydrogen electrochemically

Kaji Technology Corp. (Osaka; www.kajitech.com) and Toray Industries, Inc. (Tokyo, both Japan; www.toray.com) have jointly completed developing and demonstrating an electrochemical hydrogen pump system earlier this year. This effort was part of a project, funded by the New Energy and Industrial Technology Development Organization (NEDO; Kawasaki, Japan), aimed at reducing the costs of H_2-refueling stations.

The electrochemical hydrogen pump system, including a polymer electrolyte membrane (PEM) stack (diagram), compresses H_2 using renewable energy to perform the oxidation-reduction reactions. H_2 is supplied to the anode side of the catalyst-coated membrane (CCM), where a Pt-alloy catalyst splits the molecule into protons. The electrons are transferred via an external circuit to a catalyst layer on the other side of the PEM, where the protons recombine as H_2 on the cathode side.

Kaji Technology and Toray are targeting the commercialization of a system that produces 4.1 Nm^3/h of H_2 at 40 MPa pressure. Toray is in charge of developing the PEM and stack. Kaji Technology developed the combined package of electrochemical H_2 pump system with the stack.

A 19.6-MPa electrochemical H_2 pump system supplied by HyET Hydrogen B.V. (Arnhem, the Netherlands; www.www.hyethydrogen.com) was installed by Kaji Technology at the electric-power storage technology research site that the Yamanashi prefectural government runs in Komekurayama, Kofu City. Demonstration testing at the site used the pump system to compress "green hydrogen" produced by solar energy with a 25-kW PEM-type electrolyzer from Toray. That setup was the fruit of another NEDO-funded project. This was the first demonstration of a continuous PEM type electrolyzer and PEM type hydrogen pump system in Japan.



Stack principle

Toray Industries

Compared to a conventional mechanical H_2 compressor, the electrochemical system is more compact, vibration- and noise-free. The two companies are working to commercialize systems running at higher capacities and pressures.

Recovering battery-grade graphite, without using HF

Typically, to achieve the high graphite purity levels demanded by lithium-ion battery (LIB) applications, processors depend on hydrofluoric acid to remove silica impurities. Now, a new graphite-purification technology that eliminates the use of highly corrosive and toxic HF is being scaled up for battery-recycling applications.

Developed by EcoGraf Ltd. (West, Perth, Australia; www.ecograf.com.au), the proprietary process not only produces high-purity graphite from mineral resources, but it also enables the recovery of high-grade graphite from end-of-life battery scrap materials. Currently, most battery-recycling processes only focus on the recovery of cathode materials, such as nickel and cobalt, leaving behind reusable graphite anode material. Battery recycler SungEel HiTech Ltd. (Gunsan, South Korea; www.sungeel.com) will employ the EcoGraf process to recover graphite anode materials, alongside its own hydrometallurgical technologies for recovering cathode materials, in two proposed recycling plants to be located in Europe and South Korea.

EcoGraf's process was designed as a more environmentally friendly alternative to the HF-based graphite-purification method, explains Andrew Spinks, EcoGraf managing director. Pilot-scale programs have been completed in Germany and Australia, and Spinks anticipates that the company's production base will be expanded to include additional facilities in Europe, as well as North America. EcoGraf is currently working on a 20,000-ton/yr graphite-manufacturing facility in Western Australia and has announced plans to build a similar plant in Europe. The multi-stage chemical process involves washing and filtering steps that eliminate the use of HF, and has been successfully applied for recovering graphite with over 99% purity from both production scrap (carbon-based waste material generated during anode manufacturing) and black mass (leftover carbon material that remains once cathode metals have been recycled from end-of-life LIBs). Notably, the graphite recovered from EcoGraf's process retains its spherical particle shape, making it readily reusable in battery applications.

New demonstration plant for cellulosic textile fibers

A new demonstration plant will significantly scale up production of sustainable textile fibers made from cellulosic raw materials. TreeToTextile AB (Stockholm, Sweden; www.treetotextile.com), jointly owned by H&M Group, Inter IKEA Group, Stora Enso and LSCS Invest, has piloted a production technology to efficiently regenerate cellulose from bio-based sources, creating staple fibers that can be used in apparel, bedding and other textile applications.

The process dissolves wood pulp in a cold alkaline solution, resulting in a cellulosic solution that can be spun into long threads of fibers. After washing, fibers are cut into staple fibers and can be passed to downstream yarn-spinning processes. Notably, the system recycles all process chemicals and water. "When compared to conventional viscose production, according to our estimations the TreeToTextile process will consume at least 33% less energy, 70% less chemicals and 80% less water," says Sigrid Barnekow, TreetoTextile CEO.

Chemical recovery is key, points out Barnekow, because it means that there are no waste or residue streams leaving the process, and it also eases some of the economic and technological burdens in scaling up the technology. TreeToTextile has been operating a pilot plant at a research partner's facility, and recently completed a third-party-verified lifecycle assessment to benchmark its emissions production against manufacturing processes for traditional bulk fibers, such as viscose (rayon), cotton and polyester. "Our next milestone is constructing a demonstration plant and preparing for market introduction," says Barnekow.

Construction has begun on a €35-million demonstration plant that will scale up fiber production to 1,500 ton/yr. The new plant will be located at Stora Enso's Nymölla mill in southern Sweden. "Hopefully TreeToTextile fibers can be an alternative to less-sustainable materials in the future. Our aim is to provide a sustainable textile fiber with a high versatility for many applications and a lower cost so that it becomes broadly available to many consumers," adds Barnekow.

including AP Ventures, Chevron Technology Ventures, New Energy Technologies and Osaka Gas USA.

Ammonia has an energy density comparable to fossil fuels and significantly higher than lithium-ion batteries and compressed or liquid H_2. It can be affordably and easily stored and transported, leveraging established infrastructure and shipping networks, and is regulated by well-developed codes and standards.

Starfire Energy's Rapid Ramp NH_3 technology produces NH_3 from renewable energy, air and water. The company has also developed its Prometheus Carbon-free Fire, a system to crack NH_3 back into H_2, providing an efficient means of green H_2 storage and transportation.

ANTI-REFLECTION

Inspired by rose petals, an anti-reflective coating has been developed by Phyton-

(Continues on p. 8)

ics (Eggenstein-Leopoldshafen, Germany; www.phytonics.tech), a spinoff from the Karlsruhe Institute of Technology (KIT; www.kit.edu). Introduced at last month's (virtual) Hannover Messe (April 12–16; Hannover, Germany), the film is the result of more than seven years of research and development work. With its combined micro- and nanostructure, it replicates the epidermis of rose petals over a large area. It almost completely suppresses reflection for all wavelengths and angles of incidence of the light. This makes it far superior to conventional anti-reflective coatings, the company says.

The Phytonics film is said to increase the yield of solar modules by up to 10%. Posters, display panels, traffic signs, furniture, packaging, facades and many other applications can also benefit from this technology. The film provides an anti-reflective coating for all kinds of surfaces and gives them a "noble velvety" appearance. Because the Phytonics film is mechanically flexible, it is also suitable for curved surfaces. It is dirt-repellent and highly resistant to environmental influences, such as ultraviolet (UV) light, moisture and temperature fluctuations, the company says. It is manufactured using a cost-effective roll-to-roll printing method and can be applied to all types of materials using standard lamination processes.

SUSTAINABLE METHANOL

Perstorp Holding AB (Malmö Perstorp, Sweden; www.perstorp.com) is planning large-scale production of sustainable methanol from captured carbon dioxide and other residue streams. This could contribute substantially towards a climate-neutral industry. Project AIR, which Perstorp has created with partners, has been approved for the next level of evaluation from the E.U. Innovation Fund.

Project AIR is a large-scale project that by 2025 will decrease annual carbon emissions into the atmosphere by half a million tons. This will be accomplished by building the world's largest carbon capture and utilization unit on Perstorp's site in Stenungsund, Sweden. Using a new electrolysis plant and taking biogas as a source, it will produce 200,000 ton/yr of sustainable methanol.

A final decision on what projects will be funded by the E.U. Innovation Fund is expected later this year. ❐

Project aims to establish supply of REEs from waste streams

An effort is underway to establish an environmentally friendly supply of rare-earth elements (REEs) from waste streams in the U.S. The project, undertaken by American Resources Corp. (Fishers, Ind.; www.americanresourcescorp.com), is focused on repositioning assets from the coal industry to restore a U.S.-based supply chain for REEs and other critical elements from environmentally problematic, REE-containing waste streams, such as acid-mine drainage and flyash, and end-of-life products, such as used Li-ion batteries and permanent magnets.

So far, the company has made eight acquisitions of legacy coal facilities in Kentucky and West Virginia, and has licensed 16 patents and pieces of university-held intellectual property to capture and purify REEs from waste. Among the key technologies is an electrolysis process developed by Gerardine Botte at Ohio University (now at Texas Tech University) for concentrating REEs from aqueous solutions like acid mine drainage and mining waste. American Resources is currently building a mobile electrolysis facility that can be transported to coal sites to generate a processed concentrate that contains approximately 10% REEs.

Another key technology is a two-stage ligand-assisted displacement (LAD) chromatography process developed at Purdue University that can separate and purify the various types of REEs with the hexadentate ligand EDTA (ethylenediaminetetraacetic acid). American Resources is in the process of selecting sites to assemble a facility to carry out the chromatography.

"Our vision from the outset was to find a viable and efficient way to capitalize on sources of elements that are going to be critical in a future circular economy with renewable energy and an electrified vehicle fleet," explains Mark LaVerghetta, head of finance and communications at American Resources. "Our process is unique in that it allows us to recycle and reprocess coal-based waste to help create a sustainable supply chain for REEs, while also cleaning up environmental problems from the thermal coal industry."

New catalyst for oxidative dehydrogenation of propane to propylene

Conventional propane dehydrogenation (PDH) is an endothermic, equilibrium-limited reaction that requires high temperatures to achieve commercially viable per-pass yields of propylene. Oxidative propane dehydrogenation has the potential to form propylene at much lower temperatures and more selectively by controlling the reaction kinetically, rather than thermodynamically. However, it has proven difficult to prevent large amounts of propane combustion and to generate sufficient amounts of propylene.

A new tandem catalyst designed and developed by researchers at Northwestern University (Evanston, Ill.; www.northwestern.edu) has generated good results in oxidatively dehydrogenating propane to propylene at selectivities of 75% and single-pass propane conversion rates of 40% at temperatures of 450°C (compared to ~600°C for conventional PDH).

The catalyst consists of a ~2-nm shell of In_2O_3 grown by atomic layer deposition (ALD) on the surface of an existing PDH catalyst (Pt nanoparticles on Al_2O_3 spheres). The In_2O_3 layering leaves the Pt nanoparticles partially exposed and brings In_2O_3, which selectively catalyzes hydrogen combustion, into close proximity with the Pt particles. "After the H atoms are removed from propane on the Pt catalyst, they can diffuse across the surface to the In_2O_3 and form water," explains Northwestern professor Justin Notestein. "For our tandem catalyst, we need to combust the H atoms very quickly, so that the oxygen isn't available to oxidize the propane or propylene on the Pt surface," he says.

"Not only can you run oxidative dehydrogenation at lower temperatures without hitting thermodynamic limits, but continuous reheating is not required, as in conventional PDH," Notestein comments, and the tandem catalyst design stabilizes the platinum against sintering, lengthening catalyst lifetime and eliminating the need for regeneration. The work was funded by the National Science Foundation Center for Innovative and Strategic Transformations of Alkane Resources (CISTAR).

AI-enabled design-and-test platform speeds bioproduct development

TeselaGen Biotechnology (San Francisco, Calif.; www.teselagen.com) has developed a platform technology that integrates software and services, while taking advantage of artificial intelligence (AI) by applying machine-learning algorithms to reduce the costs and time required for the development of biologically derived products.

"Among the main challenges in biotechnology is that developing bioproducts can take years and cost millions of dollars," says Eduardo Abeliuk, CEO of TeselaGen. "We think of ourselves as an operating system for biotech that allows the end-to-end integration of different AI-enabled software modules with other product development services." As an analogy, Abeliuk likens the way his company's platform works to facilitate the interface with outside biotechnology vendor systems and devices, to computer software operating systems that allow desktop computers to communicate with external computer networks and device drivers.

The TeselaGen platform first helps research and development scientists design combinatorial libraries of desired molecules, such as DNA and pathway assemblies – genes encoding enzymes to carry out specific reactions, and DNA sequences to regulate expression. The platform then generates the instructions for laboratory automation systems to synthesize and assemble the segments for the project. Next, the DNA assemblies are inserted into host cells to evaluate the performance of different variations. The TeselaGen system uses AI-trained models to guide efficient experimentation that is aimed at identifying the best-performing assemblies.

The TeselaGen platform grew out of a DNA assembly protocol generator called "j5", initially developed at the Joint Bioenergy Institute (Emeryville, Calif.; www.jbei.org). The TeselaGen platform has now been deployed in a variety of settings, including the following: collecting data for pilot-scale bioreactors at the Advanced Biofuels and Bioproducts Process Development Unit at Lawrence Berkeley National Laboratory (Calif.; www.lbl.gov); developing new bioproducts at LanzaTech Inc. (Skokie, Ill.; www.lanzatech.com), and optimizing metabolic pathways in yeast at the Technical University of Denmark (Lyngby; www.dtu.dk). ■

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Plant Watch

Chevron and Honeywell start up alkylation unit using new ionic-liquids technology

April 13, 2021 — Chevron Corp. (San Ramon, Calif.; www.chevron.com) and Honeywell International, Inc. (Charlotte, N.C.; www.honeywell.com) announced the commissioning and startup of the world's first commercial-scale Isoalky process unit at Chevron's Salt Lake City, Utah refinery, which utilizes ionic liquids to produce alkylate. Using a non-aqueous liquid salt, the Isoalky technology is an alternative to conventional liquid-acid alkylation systems.

Sika expands admixtures capacity and begins epoxy-resin production in Qatar

April 13, 2021 — Sika AG (Baar, Switzerland; www.sika.com) has expanded its production capacity for concrete admixtures and has also started manufacturing epoxy resins in Doha, Qatar. Sika's expanded footprint in Qatar will serve the growing construction sector, which is being boosted by the expansion of energy and utilities infrastructure in the region.

Praj Industries to set up India's largest sugarcane-syrup-based ethanol plant

April 12, 2021 — Praj Industries Ltd. (Pune, India; www.praj.net) was awarded a contract by Godavari Biorefineries Ltd. (GBL) to set up a new sugarcane-based ethanol plant in Karnataka, India. As a part of this project, Praj will expand GBL's existing ethanol-manufacturing capacity to 600,000 L/d, using sugarcane syrup feedstock. When commissioned, this plant will become India's largest-capacity syrup-based ethanol plant.

Lanxess to begin producing electrolyte solutions for lithium-ion batteries

March 30, 2021 — Through collaboration with Guangzhou Tinci Materials Technology Co., Lanxess AG (Cologne, Germany; www.lanxess.com) will begin producing electrolyte formulations for lithium-ion batteries. For electrolyte production, Lanxess will use a plant in Leverkusen, Germany, operated by its subsidiary Saltigo.

Toyota commissions commercial-scale hydrogen production site near Melbourne

March 29, 2021 — The Australian subsidiary of Toyota Corp. (Tokyo, Japan; www.toyota.com) commissioned a commercial-scale hydrogen production, storage and refueling facility at its former Altona manufacturing site near Melbourne. Hydrogen is produced on site by a 200-kW electrolyzer that has the capacity to generate up to 80 kg/d of hydrogen. Power for the electrolyzer is drawn from a combination of an 87-kW solar array, 100-kW battery storage and the main grid.

BASF invests in new superadsorbents pilot plant in Antwerp

March 26, 2021 — BASF SE (Ludwigshafen, Germany; www.basf.com) will invest €25 million to build a superabsorbents pilot plant at its *Verbund* site in Antwerp, Belgium, bolstering the company's commitment to the acrylics value chain. Proximity of the new pilot plant to BASF's superabsorbent production activities in Antwerp will accelerate scaleup and commercialization cycles.

Celanese to build new UHMW-PE facility in Europe

March 26, 2021 — Celanese Corp. (Dallas, Tex.; www.celanese.com) intends to expand its ultra-high molecular weight polyethylene (UHMW-PE) capacity in Europe with the construction of a new facility. This site is expected to start up in 2024 with an annual nameplate capacity of around 34,000 metric tons per year (m.t./yr). Site selection is currently underway.

Evonik completes sodium methylate capacity expansion in Alabama

March 23, 2021 — Evonik Industries AG (Essen, Germany; www.evonik.com) has completed a significant capacity expansion of its sodium methylate production facility located in Mobile, Ala. With the expansion, the production unit will now be capable of producing up to 90,000 m.t./yr. Besides Mobile, Evonik also produces sodium methylate in Germany and Argentina.

Eastman to upgrade extrusion capacity at Massachusetts facility

March 23, 2021 — Eastman Chemical Co. (Kingsport, Tenn.; www.eastman.com) is investing to upgrade and expand the extrusion capabilities at its manufacturing facility in Springfield, Ma. The investment will increase Eastman's supply capability for polyvinyl butyral (PVB) products. The project is expected to be complete in the fourth quarter of 2021.

Mergers & Acquisitions

Veolia and Suez move forward with merger plans

April 12, 2021 — The board of directors of Veolia Environnement S.A. (www.veolia.com) and Suez S.A. (both Paris, France; www.suez.com) reached an agreement on the key terms and conditions of a merger between the two groups. This agreement would create a global entity with revenues of around €37 billion.

Hexpol acquires Spain-based rubber compounder Unica

April 12, 2021 — Hexpol AB (Malmö, Sweden; www.hexpol.com) has signed an agreement to acquire 100% of rubber compound manufacturer

Unión de Industrias C.A., S.A. (Unica) from private-equity firm Espiga Capital. Unica operates an advanced compounding facility in Corella, Spain, which serves customers in the automotive, construction and agriculture sectors.

Linde sells refrigerants business in Austria to TEGA

April 7, 2021 — TEGA GmbH (Würzburg, Germany; www.tega.de) has acquired Linde plc's (Guildford, U.K.; www.linde.com) Austrian refrigerant business. TEGA's local subsidiary, TEGA Austria GmbH, is based in Enns (near Linz), and includes a sales office and local warehouse.

Accenture and Sumitomo Chemical form digitalization JV

April 1, 2021 — Accenture plc (Dublin, Ireland; www.accenture.com) and Sumitomo Chemical Co. (Tokyo, Japan; www.sumitomo-chem.co.jp) have established a joint venture (JV) called Sumika DX Accent. The JV will leverage the power of artificial intelligence (AI), data analytics and other technologies to transform operations and create new businesses at Sumitomo Chemical Group. It is 80% owned by Sumitomo Chemical and 20% by Accenture.

DSM acquires bio-based intermediates assets from Amyris

March 31, 2021 — Royal DSM N.V. (Herleen, the Netherlands; www.dsm.com) has reached an agreement to acquire the flavor and fragrance bio-based intermediates business of Amyris, Inc. (Emeryville, Calif.; www.amyris.com), which extends DSM's offerings in aroma ingredients with bio-based ingredients for the flavor, fragrance and cosmetics industries. DSM will acquire the business for around $150 million. In recent years, DSM also acquired Amyris' farnesene business and technologies, as well as biotechnology manufacturing facilities in Brazil.

Petrobras approves sale of RLAM petroleum refinery

March 29, 2021 — Petróleo Brasileiro S.A. (Petrobras; Rio de Janeiro, Brazil; www.petrobras.com.br) has approved the sale of its Landulpho Alves Refinery (RLAM) and its associated logistics assets, located in São Francisco do Conde, Bahia, Brazil, to Mubadala Capital for $1.65 billion. RLAM is the first of eight Petrobras petroleum refineries that are being divested to have its sale completed.

Eni to acquire Italian biogas producer FRI-EL Biogas Holding

March 23, 2021 — Eni S.p.A.'s (Rome, Italy; www.eni.com) subsidiary Ecofuel and FRI-EL Greenpower have reached an agreement for Eni to acquire FRI-EL Biogas Holding Co., a biogas producer based in Rome. FRI-EL Biogas Holding owns 21 plants generating electricity from biogas, as well as a plant for processing the organic fraction of municipal solid waste, which Eni intends to convert to produce biomethane. When fully operational, this plant will supply over 50 million m^3/yr of biomethane. ■

Mary Page Bailey

Renewable Feed, New Technology and C2C Strategies Offer Opportunities for Refiners

After a rough past year, petroleum refineries are seeking profit opportunities through the use of renewable feedstocks, such as vegetable oils and waste fats, as well as with new alkylation technologies and by increasing "crude-to-chemicals" (C2C) approaches

The past 18 months have generally been extraordinarily challenging for the world's petroleum refineries, as pandemic-related restrictions dramatically reduced demand for refinery products and cut refinery utilization rates. Even with demand for transportation fuels returning as the world economy begins to emerge from the pandemic, long-term growth in gasoline and diesel fuel demand is not expected. Flat fuel demand growth, coupled with a broader trend toward decarbonizing the energy sector and increasing investment tied to environmental, social and governance (ESG), is driving petroleum refiners to seek profit opportunities through changes in the products they make and the methods they use to make them.

One area seeing a tremendous amount of activity is the production of renewable diesel fuel (see sidebar). Driven by potentially lucrative subsidies for renewable fuels and other government policies — including the trading of RIN credits [renewable identification numbers; the currency of the U.S. Enviromental Protection Agency's (EPA) Renewable Fuel Standard (RFS) program], the recently renewed biodiesel tax credit, along with state-level programs, such as Low-Carbon Fuel Standards in California, Oregon and British Columbia — many refiners are looking to expand production of renewable diesel by repurposing underutilized refining assets. The current incentives, coupled with new technologies for renewable fuels, are justifying revamps and new builds for renewable diesel projects.

Renewable diesel

An example of a tool that can help refiners take advantage of opportunities in this area is a new, simplified version of Honeywell UOP LLC's (Des Plaines, Ill.; www.uop.com) "Ecofining" process for the production of renewable diesel fuel. UOP launched the new version earlier this year as a single-stage technology designed to be a fast-to-market, low-capital-cost technology option that can be ideal for repurposing an underutilized hydrotreating or hydrocracking unit.

Ben Owens, vice president and general manager, Honeywell Sustainable Technology Solutions, says that over the past two years, two factors have combined to motivate the company toward developing the single-stage version of Ecofining. "There's been a lot of movement on biodiesel as companies seek to meet sustainability goals and pay more attention to ESG reporting," Owens points out, and "there are a lot of idled assets that refiners are trying to figure out how to use." Owens specifically cites a tripling of the number of biofuels-related projects in development, and a sharp increase in refining revamps aimed at making renewable fuels.

Those factors drove the development of Single-Stage Ecofining, which Owens says is 50–70% less expensive than the original, two-stage Ecofining, because of a simplified design, and can reach production in 12 months, versus at least three years for a greenfield project (Figure 1).

FIGURE 1. The single-stage version of the Ecofining process for renewable diesel is designed as a fast-to-market, low-capital-cost option

The single-stage Ecofining process produces Honeywell Green Diesel fuel from vegetable oils, used cooking oils, and inedible corn oil. Honeywell Green Diesel is chemically identical to petroleum-based diesel and can be used as a drop-in replacement in vehicles with no modifications. Green Diesel also features up to an 80% lifecycle reduction in greenhouse gas emissions compared with diesel made from petroleum, Honeywell says.

The faster speed to market of the single-stage unit requires a tradeoff in feedstock flexibility, however. With its greater feedstock flexibility, the two-stage Ecofining can make renewable jet fuel, while the single-stage Ecofining "is probably going to be focused more on making diesel from underutilized refinery assets, depending on the refinery's unique situation relative to feedstock logistics," Owens says.

The new, single-stage process uses a combination of catalysts in a single unit to clean and remove oxygenates and other contaminants from the feedstock, and then isomerize the feed to improve its cold-flow properties. "We developed a new process

design and catalysts that combine the hydrotreating and isomerization functions into a single reactor system operating in a sour environment with sulfur, nitrogen, water and carbon oxides," Owens explains. "The new highly selective catalysts remove sulfur and nitrogen from the feeds and isomerize the oils to raise cetane values," he says, "minimizing cracking and maximizing isomerization to deliver high yields of renewable diesel."

A single-stage Ecofining system can subsequently expand into a full two-stage Ecofining process, if desired by the refinery, UOP says. Currently, single-stage Eco-fining setups are in the design phase at several petroleum refineries. UOP invented the original Ecofining jointly with Eni Sp.A. 10 years ago.

Co-processing

Another strategy related to renewable diesel is co-processing biologically derived feedstock alongside conventional petroleum-based feedstock. An example of this comes from MOL Group (Budapest, Hungary; www.molgroup.info), a petroleum refiner with facilities in Hungary, Slovakia and Croatia. MOL is moving into biofuels production as it looks to the future of vehicle fuels markets. In March, MOL announced an initiative to co-process vegetable oils along with crude oil to make diesel fuel with higher renewable content.

"Bio-feedstock will be co-processed together with fossil materials, increasing the renewable share of fuels and reducing up to 200,000 ton/yr CO_2 emissions without negatively affecting fuel quality," says MOL Group Executive Vice President of Downstream Gabriel Szabó. "This is in line with our 'Shape Tomorrow' strategy, where we plan to produce 100,000 ton/yr of advanced biofuels by 2030." The co-processing unit has been operating successfully since last year (Figure 2).

MOL R&D over the past several years has overcome several challenges associated with co-processing bio-based materials. "The main problems are that the feed is non-homogeneous, so you need catalysts that won't lose activity, and you need an efficient logistics system to

FIGURE 2. The photo shows the reactors for co-processing renewable feedstock for diesel production

RENEWABLE DIESEL PRODUCTION ON THE RISE: ONGOING PROJECTS

Currently, production of renewable diesel fuel is relatively small compared to petroleum-based diesel, but there are a number of projects in the U.S. and abroad — some under construction and others proposed — that will dramatically increase the volume of renewable diesel available. According to forecasts from the International Energy Agency (Paris, France; www.iea.org), production of renewable diesel in the U.S. will increase from 9 billion L in 2020 to an average of 17 billion L annually from 2023-2025.

Renewable diesel differs from biodiesel in that renewable diesel consists of hydrocarbons produced by hydrotreating non-petroleum vegetable oils, such as refined soybean oil, distiller's corn oil or waste animal fats from poultry and beef production, while biodiesel is a mono-alkyl ester (fatty acid methyl ester) formed by transesterification of bio-derived oils. Biodiesel is typically used to blend with conventional petroleum-derived diesel, while renewable diesel is a drop-in replacement for petroleum-derived diesel. Typical vegetable oils and animal fats used in renewable diesel production are triglycerides with C16 and C18 chains that undergo a hydrotreating process.

The following is a selection of ongoing projects in the area of renewable diesel:

•Honeywell recently announced that Brazil-based ECB Group (Sao Paulo; www.ecb-group.com.br) will use the UOP Ecofining process to convert vegetable oils and inedible animal fats into renewable diesel and jet fuel at the Omega Green production facility in Villeta, near Asuncion, Paraguay. Honeywell UOP has designed the Omega Green project to minimize fossil CO_2 emissions at the site by using the renewable LPG and naphtha produced in the UOP Ecofining unit to self-sustain the process in energy and hydrogen. In partnership with the engineering firm Wood PLC (Aberdeen, U.K.; www.woodplc.com), Honeywell UOP will integrate Wood's hydrogen plant technology with the Ecofining unit design to produce hydrogen from renewable feedstocks to further reduce carbon intensity. When it enters operation, Omega Green will produce up to 20,000 barrels per day (bbl/d) of renewable diesel and jet fuel

• Marathon Petroleum Corp. (Findlay, Ohio; www.marathonpetroleum.com) is now producing 12,000 bbl/d of renewable diesel at its plant in Dickinson, N.D. The plant began production in the first quarter of this year and expects to hit full rates soon. Marathon plans to transport the renewable diesel by rail to the California market to benefit from that state's Low-Carbon Fuel Standard. The company has also announced plans earlier this year to convert its Martinez, Calif. refinery into a renewable-fuels production facility. The Martinez facility is expected to start producing renewable diesel in 2022 and build to full capacity in 2023

• Diamond Green Diesel (Norco, La.; www.diamondgreendiesel.com), the largest renewable diesel facility in the U.S., is the result of a joint venture between Valero Corp. and Darling Ingredients Inc. Diamond Green Diesel is expanding capacity for renewable diesel at its Norco, La. site using Honeywell UOP's Ecofining process. Diamond Green Diesel plans to build another renewable diesel plant in Port Arthur, Texas

• Revamp work is underway at CVR Energy Inc.'s (Sugar Land, Tex.; www.cvrenergy.com) Wynnewood Refinery in Oklahoma to convert an existing hydrocracker to produce renewable diesel from soybean oil. The project has selected Haldor Topsoe's (Lyngby, Denmark; www.topsoe.com) HydroFlex technology for the production. HydroFlex is commercially proven technology that can be deployed in both grassroots units and revamps for co-processing or stand-alone applications.

• Holly Frontier Corp. (Dallas, Tex.; www.hollyfrontier.com) is building a renewable diesel unit at its Artesia, New Mexico. facility that will use Haldor Topsoe's HydroFlex technology. The project is expected to begin producing renewable diesel in the first quarter of 2022. Along with its N.M. project, HollyFrontier intends to repurpose its Cheyenne, Wyoming, refinery to produce 90 million gal/yr of renewable diesel. The company expects the project to be completed in early 2022

• Last year, Global Clean Energy Holdings Inc. (Long Beach, Calif.; www.gceholdings.com) acquired the Alon Bakersfield Refinery and is now retrofitting the facility to produce renewable diesel, liquid propane from a variety of feedstocks including waste fats, used cooking oil, soybean oil and distillers corn oil—as well as GCEH's proprietary camelina oil. The project will use HydroFlex technology.

• In 2020, Ryze Renewables LLC (Sparks, Nev.; www.ryzerenewables.com) developed, then sold its interest in, a 3,500-bbl/d renewable diesel facility near Reno, Nev. The company is now working on building a larger-scale renewable diesel facility near Las Vegas, Nevada.

• World Energy LLC (Boston, Mass.; www.worldenergy.net) is expanding its Paramount, Calif. refinery to produce renewable diesel, as well as sustainable aviation fuel and propane from inedible agricultural waste. The project is reported to be completed in 2023

• Renewable Energy Group Inc. (Ames, Iowa; www.regi.com) is currently expanding capacity to produce lower-carbon renewable diesel at its Geismar, La. refinery from 90 million gal/yr to 340 million gal/yr. Construction is expected to be completed in 2023.

• Last year, Phillips 66 (Houston; www.phillips66.com) announced plans to convert its San Francisco Refinery in Rodeo, Calif., from a crude-oil-processing facility to one that produces renewable fuels. The plant would convert used cooking oil, fats, greases and soybean oils into 680 million gal/yr of renewable diesel, renewable gasoline and sustainable jet fuel. Production of renewable fuels is expected to begin in 2024

• Next Renewable Fuels Inc. (Houston; www.nextrenewables.com) is building a renewable diesel production facility in Port Westward, Oregon. The site will eventually produce 50,000 bbl/d and is expected to open in 2024

• Grön Fuels, LLC (www.fidelisinfra.com) has proposed building a 60,000 bbl/d renewable diesel production facility in Baton, Rouge, La. The project is expected to break ground in 2021 and will use Haldor Topsoe's Hydroflex technology ❑

get the bio-feedstock to the refining site," Szabó says. "Also, the renewable components have added potential for corrosion."

The site is now using vegetable oils as the bio-based component, but will expand in the future to accommodate used cooking oils, waste animal fats and other potential waste and advanced feedstock. Szabó says the company has also built logistics infrastructure to allow bio-based waste fats and oils to arrive by rail or by truck, as well as storage facilities.

The co-processing results in gasoil that is partly renewable, without any quality differences compared to diesel produced entirely from crude oil. "The main advantage of this innovative method is that the resultant diesel with bio-content can still be blended further with a maximum 7% biofuel, in line with diesel standards, allowing the bio-share of the gasoil to be higher," MOL Group says.

The share of transportation fuels that must be renewable is increasing in the European Union, and it has been met so far by blending gasoline with bio-based ethanol and blending diesel with biodiesel. The co-processing arrangement allows for a higher share of bio-based content because the co-processed diesel already has bio content, but since it is identical to petroleum-derived diesel, it can still be blended further with biodiesel.

MOL plans to invest $1 billion on new projects focused on sustainability and decarbonization over the next five years.

Another example where co-processing renewable feedstock is

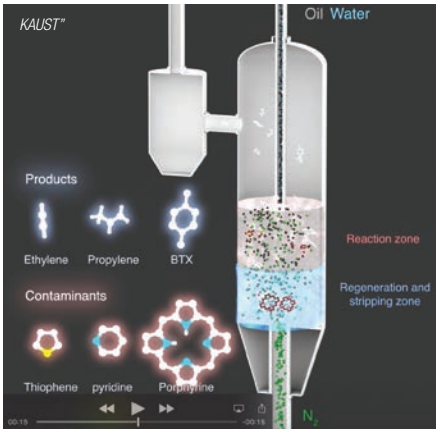


FIGURE 3. This new multi-zone fluidized-bed reactor can support production of petrochemical feedstocks from crude oil

at play appears in the sustainable aviation fuel sector. Earlier this year, Spanish fuel manufacturer Repsol S.A. (Madrid; www.repsol.com) announced the industrial-scale manufacture of aviation fuel with biologically derived content at its complex in Tarragona, Spain. The company developed a proprietary co-processing route where its "biojet" fuel is produced in parallel with kerosene production. The biological component of the fuel is made via a hydrogenated esters and fatty acids (HEFA) process, starting with vegetable-derived materials.

The first batch of biojet fuel totaled 10,000 tons and had renewable content of 5%, which complies with the quality requirements established in international specifications.

Repsol plans to extend the production of biojet fuel to its other sites, and to introduce a continuous process (the two initial runs were batch processes).

Refinery-petrochem integration

Over the past year, "Integrated refinery and petrochemical sites significantly outperformed their fuels-only peers," according to industry analyst Wood Mackenzie (Edinburgh, U.K.; www.woodmac.com). "This switch in demand away from gasoline to petrochemicals promotes the adoption of refinery and petrochemical integration, particularly for new facilities in Asia and the Middle East.

An example of new technology supporting the trend toward production of chemical building blocks from crude oil comes from a research partnership between the King Abdullah University of Science and Technology (KAUST; Thuwal, Saudi Arabia; www.kaust.edu.sa) and Saudi Aramco (Dhahran, Saudi Arabia; www.aramco.com). A research team led by KAUST professor Jorge Gascon has developed a new multi-zone fluidized-bed reactor and a new catalyst material that is capable of performing several refinery upgrading steps, resulting in the stable conversion of crude oil to light olefins in a single reactor with minimal byproduct production.

The one-step C2C transformation could prove to be a critical process approach as demand for gasoline and diesel decreases and demand for petrochemicals rises. The technol-

ogy could also help conserve energy as less energy-intensive steps are required.

Currently, the researchers point out, most C2C processes combine technologically mature units (high-severity fluid catalytic cracking (FCC) units and naphtha crackers) to maximize the production of ethylene, propylene and aromatics. "Although economically attractive, this approach still requires the use of oil pre-treatment processes [hydrotreating], energy-intensive distillation units for separating different fractions and the primary products of FCC, and the use of other energy-intensive units, such as steam crackers," the team writes in a recent study in *Nature Catalysis*.

The multi-zone configuration of the reactor allows for in-situ catalyst stripping and regeneration, the KAUST team says, where catalyst particles undergo cycles of deactivation, stripping and regeneration in separate zones of the same fluidized-bed vessel (Figure 3). Meanwhile, the incorporation of silicon carbide (SiC) into the catalyst improves its physical, mechanical and heat-transport properties. As a result, this reactor-catalyst combination has shown stable conversion of untreated Arabian Light crude oil into light olefins with per-pass yields of over 30 wt.% with a minimum production of dry gas, the researchers say.

The untreated crude oil is fed into the reactor at the middle of the vessel, which has the cracking zone at the top section and the stripping zone and catalyst regeneration at the bottom, Gascon explains. "Different reaction zones in the reactor vessel can be fine-tuned to achieve different environments and residence times with continuous operation of the catalyst," he says.

"Carrying out cracking and stripping in the same reactor obviates the need for several units in the process," Gascon says, and "you can utilize the energy from coke burning to run the cracking reaction, while maintaining the activity of the catalyst."

The KAUST team is currently building a mini-pilot plant (capable of processing 10 L of crude oil per day) in order to conduct material and energy balances and economic analyses for the process, as well as evaluating its performance on other types of crude.

New alkylation technologies

Alkylate, formed by the reaction of light olefins (such as butylene) with isobutane, is the most sought-after blendstock for gasoline because of its high research octane number (RON) values and low (or no) sulfur content. Two new technologies launched this year can improve alkylation operations at refineries.

In April 2021, Chevron Corp. (San Ramon, Calif.; www.chevron.com) and Honeywell announced the commissioning and startup of the world's first commercial-scale IsoAlky process unit at Chevron's Salt Lake City refinery. IsoAlky technology utilizes ionic liquids to produce alkylate, and is designed to offer a cost-effective and safer alternative to conventional liquid-acid systems. Using a non-aqueous liquid salt, or ionic liquid as a catalyst (rather than hydrofluoric or sulfuric acid), the new process requires only standard personal protective equipment and produces a valuable high-octane blending component. IsoAlky technology was pioneered by Chevron USA Inc. and licensed to Honeywell UOP to offer the technology to the wider entire industry.

Bryan Glover, president and CEO of Honeywell UOP says "Ionic liquids have strong acid properties that enable them to produce alkylate without the volatility of conventional acids, allowing for simpler handling procedures." He adds that the newly commercialized technology canpromote cleaner-burning fuels at a lower cost while simplifying complex handling requirements."

IsoAlky can be used in new refineries, as well as existing facilities undergoing capital expansion or retrofits. The technology has wider and improved feed flexibility relative to conventional alkylation technologies, Glover says, and the ionic-liquid catalyst material is regenerated onsite, eliminating the need to transport it offsite for regeneration and polymer byproduct handling.

In another alkylation-related development, Lummus Technology (Houston; www.lummustechnology.com) recently announced the startup of its first C5 CDAlky unit at Valero Energy Corp.'s (San Antonio, Tex.; www.valero.com) St. Charles Refinery in Norco, La. C5 CDAlky is a new version of the company's CDAlky technology, a low-temperature sulfuric acid alkylation process.

The St. Charles installation is the first C5 CDAlky alkylation unit in the world, and Lummus' first CDAlky unit in the U.S. Lummus developed this new version of the alkylation platform to process low-value C5 feedstock at its pilot plant facility in Pasadena, Texas. A depentanizer column is used to recover C5 olefins from light cat naphtha and to remove impurities from feedstocks. The CDAlky unit converts C5 olefins into a superior alkylate product with minimum acid consumption. The capacity of the new C5 CDAlky alkylation complex is 17,000 bbl/d of alkylate product.

The C5 CDAlky version employs the same core technology as the original technology, but couples the CDAlky with a CDHydro depentanizer, a specific pretreatment system for fractionating and hydrogenating C5 impurities, such as cyclopentene and pentadienes.

"In the past, refiners would need a depentanizer plus a hydrogenation step to deal with the C5 stream, but through process intensification the CDHydro uses the principles of catalytic distillation to separate the C5 feedstock and to remove impurities in the same unit," explains Todd Vogt, head of refining at Lummus.

"With this system, refiners can take the C5 stream and turn it into high-value gasoline blendstock," adds Jackeline Medina, Lummus technology manager for alkylation technologies (Lummus was previously owned by McDermott International, but was recently spun off as a standalone company). ■

Scott Jenkins

Editor's note: For additional information on the petroleum refining segment, including a new process configuration for the production of premium gasoline from naphtha, and projects for manufacturing sustainable aviation fuels, visit www.chemengonline.com for an extended version of this article.

Maintenance Tools

Improve schedule compliance and first-time fix rate

Last December, this company added MyAssets toolset to its My-Emerson personalized digital experience to help users execute their maintenance plans more effectively. As part of the MyEmerson digital tools portfolio launched last year to improve productivity and collaboration, MyAssets provides instant access to device documentation, replacements, spares and walk-down reports to help plant personnel better maintain and manage the useful life of their devices. For maintenance planners, MyAssets improves schedule compliance with a single location for device information, technical documentation, spare and replacement part details and lifecycle status condition. Easy access to curated, relevant device content enables faster creation of work packets, reducing time from hours to minutes. Digital walkdown reports provide detailed analyses of a site's device conditions — regardless of manufacturer — and prioritized recommendations for next steps, guiding faster and more predictable shutdowns, turnarounds and outages. — *Emerson, St. Louis, Mo.*
www.emerson.com

Align most standard machines with this laser-based system

The ShaftAlign Touch laser alignment system (photo) is a digital solution that exceeds the capabilities of conventional tools and delivers greater speed and accuracy. The user-friendly system combines single-laser technology with Active Situational Intelligence to empower teams of varying experience levels to align most any asset with new levels of precision and speed. The company's Adaptive Alignment systems, such as the ShaftAlign Touch, automatically eliminate user errors and low-quality measurement points by adapting to the asset, the alignment situation, and the technician who is performing the job. Cloud-compatible software allows newer technicians to share measurements with more experienced colleagues or consultants — inside the plant or across the globe — to complete a job. — *Prüftechnik, a division of Fluke Reliability, Ismaning, Germany*
www.pruftechnik.com

Global partnership for digital maintenance

Last March, this company and Evora IT Solutions (Walldorf, Germany) announced a global solution and technology partnership. Both companies complement their own offerings by combining mobile hardware and software solutions for digital maintenance in the specialized, demanding industrial sector. In a first software/hardware pilot project, a joint major chemical customer of the two companies is already successfully using this company's IS930.RG tablet (photo) for SAP-supported maintenance processes. Both companies will be able to offer their global users the added value of the combined integration of solutions/software and hardware for Ex or rugged industrial use. — *i.safe Mobile GmbH, Lauda-Koenigshofen, Germany*
www.isafe-mobile.com

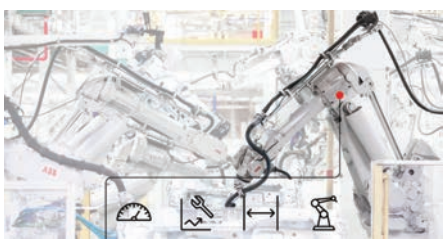
Improved robot fleet management with CBM

This company's new condition-based maintenance (CBM) service enables robot users to create a preventive maintenance schedule for individual or robot fleets based on real-time operational data to optimize productivity and minimize downtime (photo). CBM uses real-time data on robot operations to help identify any potential issues that could affect performance, including duty, speed, acceleration and gearbox wear. These variables are compared against other robots in the company's worldwide robot database to calculate the likelihood and timeframe of a potential fault or failure. Aimed at users with large fleets of robots, this CBM tool can advise whether remedial action is required, involving either repair or replacement of affected parts. By identifying which parts are likely to fail and when, spare parts can be

Emerson

Prüftechnik, a division of Fluke Reliability

i.safe Mobile



ABB

Madison Chemical Co.

Cortec

Hayward Gordon Group

ECOM Instruments

purchased and prepared without having to hold them in stock, helping users to plan their budgets and ensure that resources are available to carry out the work when required. — *ABB, Zurich, Switzerland*
www.abb.com

This detergent breaks down fats and other organic soils

Pure-OX FOAM (photo) is a peroxide-based foaming detergent specifically formulated for tough organic soils on equipment or floors, walls, ceilings, shelves and other surfaces within food-processing environments. With the self-foaming characteristics of peroxide, Pure-OX FOAM provides cleaning power and convenience in a single package. Once the powerful oxidation reaction is complete, the degradation products are oxygen and water, so Pure-OX FOAM will not add salt or conductivity to water discharge, nor will it impact wastewater pretreatment operations, says the manufacturer. Ideal for foam cleaning, it readily breaks down proteins, fats, greases, oils and other organic soils found in food-and-beverage processing facilities, especially dairy, poultry, wine, meat processing and more. All ingredients in Pure-OX FOAM are generally recognized as safe (GRAS) or have prior-sanctioned U.S. Food and Drug Admin. (FDA) approval for direct or indirect incidental food contact. — *Madison Chemical Co., Inc., Madison, Ind.*
www.madchem.com

'Green' cleaner removes organic stains from concrete

In December, this company introduced a new addition to its line of MCI cleaners for concrete. MCI-2062 is a biological-based surface cleaner similar to MCI-2061. Both MCI cleaners make use of the natural abilities of microorganisms to biodegrade their target waste substances effectively without the use of harsh acidic or alkaline products. However, where MCI-2061 focuses on the critical task of digesting hydrocarbon stains, MCI-2062 targets stains from organic wastes, proteins, fats, greases and starches. It is therefore particularly suited to concrete heavily soiled by organic wastes in and around dumpsters, restrooms and food processing facilities (photo). MCI-2062 is a multipurpose concentrated bio-enzymatic blend formulated for general cleaning on a variety of surfaces. It combines powerful cleaning chemistry with free enzymes and microorganisms capable of biodegrading a wide range of organic waste in order to leave facilities clean and odor-free. — *Cortec Corp., St. Paul, Minn.*
www.cortecvci.com

Predictive monitoring for pump and mixer maintenance

This company's Risk-Mitigation System (RMS) monitor (photo) provides continuous indication of potential problems with pumps and mixers. Predictive information supplied by the monitor enables users to address issues before mechanical failure occurs, reducing the risk of equipment damage and unplanned downtime. Attached to a pump or mixer, the system tracks temperature and vibrations and issues alerts if it detects any unusual changes. The RMS monitor can also be programmed to watch for other potential hazards, such as leakage and cavitation. In this manner, costly mechanical failures involving bearings, seals and other components can be avoided. With cellular network connectivity, the RMS monitor requires no wiring. Components and sensors are housed in a single, compact unit protected by a robust rubber enclosure. — *Hayward Gordon Group, Halton Hills, Calif.*
www.haywardgordongroup.com

Digital products support businesses of all sizes

More and more small and medium-sized companies are using company-owned mobile devices. In addition to serving as communication tools, they can also be used as digital hubs or for lone worker protection. In doing so, smartphones and tablets are issued not only within a single location, but worldwide. The management of the increasingly large number of devices is therefore often associated with great effort. For these companies, a mobile device management (MDM) system must above all be easy to implement and require little time in daily use. The MDM solution developed by this company (photo) is suitable for large and small companies alike. It is an instant-on solution that can

be implemented without major IT effort. This makes the administration of mobile devices within a company more efficient and secure. Setting up, managing, tracking and configuring the devices can be done from a central platform with a single click, without the IT department, to take control of every single device and set them up individually. This saves resources and time without having to renounce a unified and secure infrastructure. Device setup is highly efficient, using standard jobs and policies. — *ECOM Instruments GmbH, a Pepperl+Fuchs brand, Assamstadt, Germany*
www.ecom-ex.com

Enhanced calibrator maintenance with more options

This company has introduced enhancements to its Care Plan equipment-maintenance solution to provide users with additional flexibility when selecting a solution to meet their unique needs. Care Plan offers an easy way for users to maintain the accuracy and reliability of their calibration equipment throughout its lifetime. With a Care Plan in place, users can ensure that the metrological traceability of their critical calibration equipment is maintained with periodic recalibrations. They also benefit from the assurance that necessary maintenance and repairs will be covered by this company. The new enhancements make purchasing a Care Plan easier, with new fixed-price options now available. For added flexibility, in addition to the existing three-year plan, users can also purchase their plan annually. — *Beamex, Inc., Marietta, Ga.*
www.beamex.com

OPEX-based model contributes to IIoT implementation

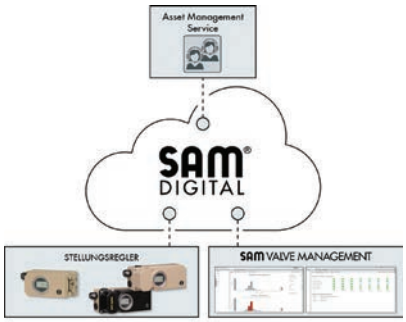
Last November, this company introduced "Wi-care as a service." This makes the industrial service provider the first organization to offer wireless vibration-monitoring as an operating expenditure (OPEX) solution. With the new service, the company aims to make it easier for firms to implement Industry 4.0 and the internet of things (IIoT). Within Wi-care as a service, data plays a key role. In the first instance, it helps organizations select a data collection method that is optimal for them. Data analysts then turn the data into useable information and key performance indicators (KPIs), which users themselves can consult on a visual dashboard. The implementation of wireless monitoring has seen many obstacles, including the need for capital, the adjustment to infrastructure and upgrades to the most recent technology. In addition, the monitoring of services, the reliability of surveillance equipment, as well as the quality of analysis and service provision bring with them the usual challenges. By virtue of the OPEX model, this service is not only reliable but also easy to scale up, says the company. — *I-care, Mons, Belgium*
www.icareweb.com

Coding complexity removed for APM software

Coding challenges faced by operators implementing asset performance management (APM) software are to be significantly reduced or even removed, according to this company. The latest update to its APM software, AllAssets, is said to help drive efficiencies and cost savings, mitigate risk and simplify implementation. By using a low-code strategy, the company aims to empower companies to take control over their APM program and reduce the burden of deploying the resources needed to optimize operations and maintenance. Low code removes the need for operators to pay to adapt software to their requirements and the need for outsourced technical expertise to implement it. The approach emphasizes shifting the power from the technology provider to the user, making software, such as APM platforms, much more straightforward and systematic and less time-intensive not only to implement but to update in line with constantly changing business and regulatory requirements. Adopting a risk-based approach using APM software can help operators of all sizes adapt to the new working conditions brought on by COVID-19. By optimizing the maintenance schedule, staff will only be required on-site when it is absolutely necessary, helping to reduce their exposure. — *Lloyd's Register Group Ltd., London, U.K.*
www.lr.org ■

Gerald Ondrey

New Products



Samson

Smart monitoring and management of control valves

The web-based Sam Valve Management system (photo) gives users an overview of all connected control valves fitted with smart positioners from this company in a clearly structured dashboard displaying all relevant operating and diagnostic parameters. Malfunctions can be detected instantly. The system also analyzes all data based on an extensive range of algorithms and suggests recommended action with illustrated step-by-step instructions. The data in Sam Valve Management can be synchronized by transferring data from commonly available process control systems or Trovis-View software. The extensive diagnostic functions provided by Sam Valve Management help increase the availability of control valves by predicting imminent valve failure and maintenance demands. It also helps optimize plant profitability. — *Samson AG, Frankfurt am Main, Germany*

www.samsongroup.com

Andritz

This pusher centrifuge needs only one motor

While traditional centrifuges have separate pusher and drive motors, the ecoOne pusher centrifuge (photo) has only one motor for both functions, thus significantly reducing installed power and power consumption. Pusher centrifuges with two motors generally only require the full power of the drive motor during the startup process, and the drive motor usually operates at partial load during steady-state operation. Conversely, the pusher motor runs at virtually no-load during machine startup because there are no solids in the machine yet to be pushed. Hence, the pusher motor does not operate under load until stationary operation begins. The ecoOne technology allows the reserve capacity available for pushing to be used for accelerating the basket during the startup process, while the reserve capacity available for the startup process can be used for pushing during stationary operation. This results in significantly lower installed power use and a motor that operates in the optimum efficiency range at all times. Total power consumption is thereby reduced by around 10 to 20%, while the installed power is reduced by around 20–40%, says the company. Furthermore, the new high-pressure pushing system cuts hydraulic fluid use by up to 40%. — *Andritz AG, Graz, Austria*

www.andritz.com

Bühler

Gauging temperature and vibrations improve milling

This company's Insights platform is connected to the new temperature and vibration management (TVM) system (photo), which provides essential information on grinding processes based on proprietary algorithms. TVM detects critical operational conditions early so that proper action can be taken. Accurate management of grinding processes helps maintain the best product quality and consistency. Precise settings reduce energy consumption and product waste. The launch of TVM represents another significant step towards the fully digitalized and automated SmartMill. The TVM service is continuously developed further to maximize impact. Future features, for example, will include more advanced recommendations for automatic adjustments based on recipes. — *Bühler AG, Uzwil, Switzerland*

www.buhlergroup.com

Kaiser Optical System

New Raman spectrometers provide IIoT connectivity

The Kaiser Raman embedded analyzer (photo) collects in-situ process measurements, enabling realtime process monitoring, optimization and control. With this continuous automation, users can maintain a continuous pulse on the safety, quality and efficiency of their operations — whether in laboratory or manufacturing settings. Kaiser Raman Rxn analyzers perform self-monitoring and self-diagnostics to ensure the validity of each measurement, and to enable seamless lab-to-process model transferability and equipment scalability. This latest Raman Rxn portfolio, comprised of the Raman Rxn2 and Rxn4 base analyzer models, integrates analyzer and control software in a fixed purpose device with built-in intelligence. To ease maintenance, Raman Rxn2 and Rxn4 analyzers perform self-

WIKA Alexander Wiegand

calibration, utilizing spectral correction methods in applications when periodic system calibration is not required. The analyzers can be configured with 532-, 785- or 1,000-nm excitation wavelengths, with the ability to measure up to four channels. Measurements can be taken inline, online or at-line. — *Kaiser Optical Systems, Inc., an Endress+Hauser company, Greenwood, Ind.*
www.us.endress.com

New flange monoblock with shutoff valve

The compact design of this new monoblock with flange connection (photo) integrates a shutoff valve to separate the process from the instrument side. The one-piece construction and the double sealing (metal and plastic), tested in accordance with BS6755/ISO 5208 leakage rate A, ensure user and process safety. The model IBF1 can be fitted with either a ball valve or a needle valve. The new instrumentation valve complements the existing monoblock portfolio, which includes the models IBF2 (block and bleed) and IBF3 (double block and bleed). All IBF models can also be fitted on level indicators and differential-pressure measuring instruments for level measurement. — *WIKA Alexander Wiegand SE & Co. KG, Klingenberg/Germany*
www.wika.de

Schütz

This IBC has a compact design for streamlined shipping

The new Ecobulk MX 560 intermediate bulk container (IBC; photo) has a lower height than standard models and a nominal volume of 560 L (150 gal). The MX 560 offers a significant advantage when shipping by sea: the pallet size makes optimum use of the storage and transport space in standardized large-capacity containers, even for mixed loads with larger MX IBC variants. With triple stacking throughout, 30 IBCs of this model will fit in a 20-ft ISO container. The four horizontal tubes of the steel grid provide the necessary stability and ensure secure stacking. The large, metal label plate, which covers eight fields of the steel grid, provides plenty of space for detailed product information. With its reduced capacity and optimized footprint, the new IBC offers lower capital tie-up and shorter storage times for products with a slow turnover. The IBC can also be equipped with an ethylene vinyl alcohol (EVOH) permeation barrier, which ensures product quality, safeguards the filling product against changes in the environment and against potential contamination by stopping oxygen, nitrogen and other gases from permeating in and out of the container. — *Schütz GmbH & Co. KGaA, Selters, Germany*
www.schuetz.net

Jet-Vac Technologies

Remove toxic fumes and gases economically and effectively

The Fume Scrubber product line (photo) offers a reliable way to remove and neutralize acid fumes, noxious laboratory gases, particulate matter, odors, dust and condensable contaminants in manufacturing processes. The Fume Scrubbers work by pulling contaminated fumes and gases into the flow of a wash fluid, such as dilute sodium hydroxide. The intimate mixing of air/gas and liquid streams produces an effective and instant cleaning solution. Scrubbed of contaminants, the air/gas mixture is then separated from the wash liquid in a separation tank. The washing fluid is then recycled and reused. The effectiveness of the process is enhanced by properly matching the contacting scrubber fluid with the air or gas feed stream. This methodology is said to be more effective than filters for gas and condensable vapor removal. Furthermore, Fume Scrubber systems are not impacted by corrosive fumes and require little maintenance. — *Jet-Vac Technologies, Stoughton, Mass.*
www.jetvactechnologies.com

Reusable gas samplers for VOC analysis

The new POD (pocket diffuser) sampler (photo, p. 23) is a passive sampler that combines the benefits of radial and axial samplers for volatile organic compounds (VOCs). POD gas samplers provide improved sensitivity and accuracy, along with faster response times, when compared to other passive samplers, says the company, while also bringing the additional benefit of re-usability. POD sampler cartridges can be reconditioned and reused over 100 times, which is around

five times greater than traditional radial samplers, and the sampler itself can be used indefinitely. These benefits make large-scale air-monitoring studies easier to run and more affordable. Furthermore, the sampler's optimized radius ratio ultimately reduces the amount of adsorbent material required. The POD sampler is compatible with any commercial thermal desorption system. — *Markes International Ltd., Bridgend, U.K.*
www.markes.com

Improve dosing accuracy and safety for powder weighing

The XPR automatic balance (photo) applies active machine learning to powder weighing, delivering accuracy, speed and safety for weighing potentially toxic or active substances. The XPR significantly reduces exposure risk while ensuring precision and safety by dosing from an enclosed head into target vials or capsules with openings as small as six millimeters in diameter. It then uses live feedback to learn a substance's flow characteristics and improve dispensing efficiency in real time. This can be particularly effective when combined with a sample changer that can process as many as 30 samples in one automated run. Spill risk is also eliminated, as is the need to repeatedly open the balance door and transfer compounds from the main container into a secondary container. The dimensions of the balance mean that it can be operated inside a glove box or safety enclosure, further enhancing containment. — *Mettler Toledo, LLC, Columbus, Ohio*
www.mt.com

A smart monitoring technology for hydrocyclones

CycloneSense (photo, p. 24) is a smart measurement system that provides direct and continuous online monitoring of a hydrocyclone air core, helping to prevent common problems in hydrocyclones, such as roping, while increasing uptime. In grinding and flo-

Markes International

Mettler Toledo

Metso Outotec

tation processes, hydrocyclone operating conditions have a direct impact on overall plant availability and efficiency. CycloneSense technology allows users to visualize the performance inside the cyclone. It allows continuous online measurement of the cyclone's air core shape, size and location based on process tomography, thus helping to find and maintain the optimal operating point for the hydrocyclone. In addition, the measurement system helps to detect and prevent potential problem situations, such as roping, where the slurry is not properly separated and instead some of the larger particles are sent to the overflow and directly to the next stage of processing. Combining CycloneSense with this company's PSI particle-size analyzer allows for optimization of the cyclone cluster and grinding circuit. — *Metso Outotec Oyj, Helsinki, Finland*
www.mogroup.com

LJ Star

Illuminate critical processes with these explosion-proof LED lights

The new explosion-proof Lumiglas Model USL08LED-EX (photo) is said to be the brightest sight-glass light available on the market at 50% brighter than its competitors. Employing LED light, Lumiglas delivers a service life that is ten times greater than typical halogen lights, with one-fifth of the energy consumption. These lights can be precisely tuned to correct color temperatures, eliminating the distorting yellow glow of halogen lights that can affect vessel inspection. These sturdy, compact lights are now available with up to 2,200 lumens at a color temperature of 6,200 K. Designed for combination light/sight port or separate light- and sight-port vessel applications, Lumiglas lights are also suitable for specific area lighting, including sight-flow indicators, instruments, control panels, valve manifolds, walkways and more. The explosion-proof lights are also moisture-proof and feature an advanced shock-resistant design. Lumiglas LED lights are UL 844 listed for Class I, Division 1 & 2, Groups C & D, and Division 2 Groups A & B applications. LED lights are approved for wet conditions, UL 1571 and carry IP65 rating for dust and waterjet tight protection. — *LJ Star, Twinsburg, Ohio*
www.ljstar.com

Anova

Digitizing the industrial-gases supply chain

The Transcend IoT Platform streamlines industrial-gas supply-chain data by integrating data from multiple remote-monitored tanks, as well as adjacent equipment, such as vaporizers, compressors, pipelines, programmable logic controllers (PLCs) and other advanced systems. Users have the ability to visualize key parameters in a single platform, such as tank level and pressure, along with advanced systems flowrates, ambient temperatures, pressure and other variables, all in customizable dashboards. The insights provided by Transcend can help users access enhanced predictive analytics and accelerate digitalization across the entire supply chain. — *Anova, New Providence, N.J.*
www.anova.com

MSA Safety

New calibration technology extends gas-detector operation

The new TruCal calibration technology, included with this company's Ultima X5000 and General Monitors S5000 gas detectors (photo) for H_2S and CO, means that the devices require no calibration checks for up to 24 months. Typically, a gas sensor's electrolyte, or one or more of the electrodes, may limit the life of the sensor, especially in high-temperature or humid environments. These conditions and issues often require frequent recalibration or clearing of blocked sensors in harsh environments. The TruCal technology solves these problems with an extended calibration technology, which automatically self-checks and corrects sensor drift to extend calibration cycles using adaptive environmental-compensation (AEC) algorithms. This capability eliminates bump checks and assures the user that the sensor is healthy, measuring accurately and capable of detecting gas continuously. — *MSA Safety, Cranberry Township, Pa.*
us.msasafety.com

Application-specific liquid-mixing systems

This company's B Series of liquid mixing systems (photo, p. 25) are designed for blending, solids suspension, gas dispersion, heat transfer and low- or high-viscosity liquid

mixing, with mixing volumes up to 5,000 gal. These mixing systems can be engineered for either hygienic environments or general industrial applications, for open- or closed-tank configurations. The B Series' motor specifications include severe-duty and explosion-proof designs, stainless-steel construction and power ratings up to 5 hp. — *Brawn Mixer, Holland, Mich.*
www.brawnmixer.com

A mobile conveying system for explosive environments

The ATEX-certified Inert Explosion-proof (INEX) pneumatic vacuum-conveying system (photo) features an optional mobility package. Setting the entire conveying system on a self-contained, rolling platform, the mobile INEX system enables processors to safely convey dry and wet powders in hazardous environments where explosive vapors may be present, then easily move the entire conveying system to other production or processing lines without concern for risk of explosion. Ideal for loading metal powders and other self-ignitable materials into reactors and vessels amid flammable or explosive gases, and for transferring hybrid materials mixed with solvents, the mobile INEX pneumatic vacuum conveyor fluidizes the material with nitrogen or other inert gas to create an inert atmosphere throughout the entire conveying process. The patented approach ensures explosion-proof operation in ATEX Zone 0 areas where an explosive mixture is continuously present or present for long periods of time. — *Volkmann USA, Inc., Bristol, Pa.*
www.volkmannusa.com

Use these lined static mixers with aggressive chemicals

This company has launched a Kynar-lined static mixer (photo, p. 25) to enable homogenization and dispersion of liquids and gases without using any moving parts. Due to its enhanced

Brawn Mixer

Volkmann USA

Komax Systems

Kaeser Compressors

Valley Forge & Bolt Mfg.

Lauda Dr. R. Wobser

chemical resistance and high-temperature capacity, this mixer is appropriate for challenging chemical applications, including those using concentrated acids or other corrosive media. Constructed of 40 carbon steel, 316 stainless steel, PVC and fiberglass, these static mixers can be lined with Kynar or Teflon and are available in standard diameters ranging from 1 to 24 in. The Teflon mixing elements are 25% glass-filled for additional strength and extended lifespan. — *Komax Systems, Inc., Huntington Beach, Calif.*
www.komax.com

Compressed-air systems in a secure, weatherproof enclosure

KASE air-system enclosures (photo) is available in several standard configurations, including two 100-hp, one 250-hp, or three 100-hp rotary-screw compressor units with refrigerated dryers. Also available is a 125-hp oil-free package with a heat-of-compression dryer. Instead of selecting compressed-air equipment and coordinating onsite installation with contractors, KASE units provide complete compressed-air systems in a temperature-controlled, weatherproof enclosure, says the manufacturer. This makes them suitable for quickly expanding or replacing a compressed-air system to maximize plant productivity, or to remove a source of heat and noise from the plant and free up floor space for other uses. KASE units feature a full walk-in design, and are rated for 110-mph wind loads and 50 lb/ft^2 snow load. They include fully insulated, sound-dampening paneling, as well as entry doors and removable access panels for major service. These systems can be remotely monitored, and service providers do not need access to production areas, improving plant safety and security. — *Kaeser Compressors, Inc., Fredericksburg, Va.*
www.us.kaeser.com

Monitor bolt loads, even at high temperatures

The new High Temp Maxbolt (photo) is able to operate in temperatures up to 650°F for proven performance in extended high-temperature run times and thermal cycling. High Temp Maxbolt, like the original Maxbolt, helps to reduce downtime, premature wear and catastrophic joint failures in critical industries, including chemical processing, mining and energy. Maxbolt has a built-in analog gage that enables installation technicians to know, at a glance, when proper load is achieved. During operation, technicians literally see if load ever falls out of specification on any bolt, addressing the need immediately instead of waiting for critical equipment failure. With an accuracy of ±5%, and compliance with ASTM F2482, the High Temp Maxbolt provides realtime tension indication, and operates in both rapid thermal cycle applications and in prolonged high-temperature situations. — *Valley Forge & Bolt Mfg. Co., Phoenix, Ariz.*
www.vfbolts.com

Temperature control under a pressure blanket

This company has expanded its product range for demanding temperature-control tasks with two devices: the new, pressure-blanketed Integral P variant (photo); and a new, high-performance device of the T variant. For the P variant, two device types, Integral IN 2050 PW and IN 2560 PW, function according to the pressure-blanketing principle. The devices, which are equipped with a stainless-steel pressure vessel, significantly expand the temperature range of flammable heat carriers. In the pressure-blanketing process, the compressed air supply is used to fill the device with negative pressure, which sucks the temperature control medium into the device with a vacuum of –0.2 bars. Integral P process thermostats can be used within a working temperature range from –40 to 140°C, with a cooling capacity of 20 kW and 25 kW, respectively. — *Lauda Dr. R. Wobser GmbH & Co. KG Lauda-Königshofen, Germany*
www.lauda.de

A fast EtherCAT RFID interface for decentralized automation

The TBEC series has been added to this company's range of RFID solutions for fast interfaces to EtherCAT networks. The TBEC module (photo, p 27) in fully potted plastic housing comes with protection according to IP67/IP69K standards and can be used in an extended temperature range from –40 to 70°C.

The EtherCAT RFID module enables HF and UHF read-write heads to run at the same time, thus simplifying applications with different bandwidths and reducing the range of inventory needed. The TBEC also supports the HF continuous bus mode by which up to 32 bus-capable HF read-write heads can be connected to each of the four RFID channels. Sensors, lights or other actuators can be connected to the eight universal DXP I/Os. All terminals are implemented as five-pin M12 male connectors, and the power supply (L-coded) is implemented with the future-proof M12 power technology. — *Hans Turck GmbH & Co. KG, Mülheim an der Ruhr, Germany*
www.turck.com

Hans Turck

Stainless-steel butterfly valves help streamline material flow

This company's range of butterfly valves (photo) are offered with a highly polished 316 stainless-steel housing and disc, which make the valve suitable for many applications in the food, chemical and pharmaceutical industries. The inflatable seat design of the butterfly valve provides an improved seal by utilizing air pressure to expand the seat against the disc, providing more sealing area and an even pressure distribution against the disc every time it closes. The seat automatically compensates for wear when it inflates against the disc, extending valve life considerably. Because the valve's disc only makes casual contact with the seat during opening and closing, torque requirements are substantially lower that those experienced with other butterfly-valve configurations. This ease of movement also allows the disc to come to a precise 90-deg position every time it opens. Additionally, the smooth profile of the disc eases material flow and reduces buildup. These stainless-steel butterfly valves are available in sizes ranging from 2 to 20 in. — *Posi-flate, St. Paul, Minn.*
www.posiflate.com
Mary Page Bailey and Gerald Ondrey


Posi-flate

Evaporator Equipment Types

Department Editor: Scott Jenkins

Industrial evaporator heat-transfer surfaces are either tubular or flat plates, packaged into a variety of evaporator types, as outlined here.

TABLE 1. ADVANTAGES AND DISADVANTAGES OF DIFFERENT EVAPORATOR TYPES

Type	Advantages	Disadvantages
Batch evaporator	• Simplicity • Flexibility • Relatively low cost • Ability to handle feeds containing undissolved solids	• Low heat-transfer coefficients • Low heat-transfer area per unit volume • Lower productivity versus continuous • Not suitable for heat-sensitive products because of the extended residence time
Short-tube vertical evaporators	• Because the tubes have large diameters and short lengths, they are easily cleaned (well suited for materials requiring mechanical descaling) • Low headroom requirement • Proven designs • Relatively low cost	• Low heat-transfer coefficients • Low heat-transfer area per unit volume • High floor-space requirement and weight • High holdup of process material • Use with corrosive materials is expensive, because evaporator bodies would need to be made from corrosion-resistant alloys
Long-tube vertical evaporators	• Product is a thin film (not filling entire tube volume), so liquid holdup and residence time, are low (lower heat exposure) • Low cost per unit area • Simple construction and small floor footprint • Ability to handle foamy liquids • Ability to handle corrosive process streams	High-viscosity fluids (>300–400 cP) are not suitable because film formation is difficult
Forced-circulation evaporators	Chosen when a film evaporator will not work. Such applications include viscous liquids, because these kinds of liquids do not form films easily	• Less efficient than film evaporators • Lower heat-transfer coefficients than thin-film, so higher cost per unit area • Cost is higher because a large circulation pump and piping are required
Plate evaporators	• Corrugations and tortuous flow path lead to turbulent flow at low Reynolds numbers • The resulting high heat-transfer coefficients allow a given evaporation rate to be reached at a lower ΔT • Low holdup and short residence times, so good for heat-sensitive products • High fluid velocity results in better heat transfer and a lower rate of fouling compared to tubular evaporators • Plate packs are easily disassembled for inspection and cleaning	• A propensity for air leakage at higher temperatures • Not economical for high capacities
Agitated thin-film evaporators	Residence time is short (a few seconds), and residence-time distribution is narrow	Unlike the other types of evaporators discussed, the agitated TFE is typically used with organic, rather than aqueous, systems

Batch evaporators

Batch evaporators are vessels with a heating jacket or internal coil, an overhead condenser, a condensate receiver, and usually, a vacuum source. After feed is charged into the vessel, heat is applied and evaporated vapor is condensed overhead, while the contents of the vessel decrease in volume and increase in concentration of non-volatile materials.

Short-tube vertical evaporators

A shell-and-tube heat exchanger is situated inside the evaporator vessel, near the bottom. The heat exchanger, called the calandria, contains an open area at the center, known as the downtake. Process fluid circulates upward through the calandria tubes, against condensing steam on the shell side. The vapor formed travels to the top of the evaporator, where entrained liquid droplets coalesce on a mesh pad and fall back into the boiling liquid. Meanwhile, the liquid emerging from the calandria tubes travels downward through the downtake, then back up through the tubes for a subsequent pass. Circulation occurs by natural convection.

Long-tube vertical evaporators

These evaporators operate with a thin film of liquid on the heat-transfer surface. As evaporation takes place, vapor fills the core of the flow channel, which thins and accelerates the film.

Forced-circulation evaporators

With this type, process fluid circulates from the vapor-liquid separator (flash chamber) through the heat exchanger and back. The orifice plate applies enough backpressure to prevent boiling in the heat exchanger. Only sensible heat (no latent heat) is transferred in the heat exchanger, and the process liquid exits the heat exchanger at a temperature above the boiling point at the prevailing pressure in the flash chamber. The flashed vapor is directed to an overhead condenser, usually via a mesh pad to recover entrained liquid droplets. Meanwhile, the concentrated liquid makes another pass through the heat exchanger, with some new feed added, and some concentrate removed as product.

Plate evaporators

This type has a series of corrugated metal plates, separated by gaskets around the periphery of each plate. The plates are pressed together to form a series of flow channels. Steam and process fluid are directed to alternate channels, and heat is transferred across each plate from the steam side to the process side. Slotted openings and seals direct the various streams. Baffles create a tortuous flow path for the fluid, increasing local velocity, and in turn, heat-transfer efficiency.

Agitated thin-film evaporators

These evaporators form films mechanically, using a rotating blade near (or contacting) the heat-transfer surface. The device has a mechanical rotor concentric to a cylindrical, jacketed body. Feed entering the top is distributed evenly by the rotor, then the fluid spirals down the heated wall. Bow waves generated by the rotor blades cause high turbulence, so heat-transfer coefficients are high. Concentrate exits the bottom. Vapor travels from the heated surface to an internal condenser, concentric to the evaporator body, and the resulting condensate (distillate) proceeds downward to exit. ■

Editor's note: This content is adapted from: Gabelman, A., Evaporators: Design Concepts and Equipment Selection, *Chem. Eng.*, January 2020, pp. 27–38.

Producing Polylactic Acid from Corn

By Intratec Solutions

Polylactic acid (PLA, polylactide; Figure 1) is a thermoplastic aliphatic polyester that is derived from a number of renewable starting materials, such as starch and sugarcane, via bacterial fermentation. PLA is semicrystalline or amorphous, rigid, resilient and an ultraviolet-light-resistant material, with similar characteristics to common petrochemical industry plastics, such as polyethylene, polypropylene and polystyrene. PLA is used in plastic films, bottles and biodegradable medical devices. It figures among the most highly consumed bio-based plastics worldwide.

PLA rapidly absorbs moisture from the atmosphere and is also temperature-sensitive (storage temperatures should be below 122°F). In order to preserve PLA properties and characteristics, exposure to ambient (undried) air should be minimized. PLA is usually delivered in moisture-resistant containers, including foil-lined boxes, which can prevent moisture regain during shipping and storage. PLA is mainly used in packaging, textiles, nonwoven fabrics, electronics, automotive parts, medical devices and cutlery. Packaging is the largest application market for PLA, and will likely grow as new heat-resistant PLA blends are developed.

Polylactic acid process

The production of PLA from corn (Figure 2) involves three major sections: (1) Starch hydrolysis; (2) Glucose fermentation; and (3) Lactic acid polymerization.

Starch hydrolysis. Shelled corn is fed to grain cleaners, then sent to steeping vessels, where it is soaked in a dilute solution of sulfur dioxide, produced in a sulfur burner. The solid matter slurry obtained is submitted to a sequence of unit operations to recover cornstarch, while the steep water is concentrated in evaporators and sent as corn steep liquor (CSL) to the downstream process stages. The starch is then mixed with enzymes and sodium carbonate in the hydrolysis area to convert it to glucose, which is sent to the fermentation stage.

Glucose fermentation. The fermentation is carried out in an agitated jacketed fermenter, fed with glucose, CSL and sodium carbonate. The fermentation broth is sent to an ultrafiltration step to remove cell debris, concentrated in an evaporator, and then to an extraction column to extract the lactic acid (LA) in an organic phase, which is routed to a distillation column to separate the extractant solvent from the LA. The LA-rich stream is then back-extracted with hot water in an extractor train, generating a LA-lean organic phase, which is recycled to the first extraction stage, and an aqueous phase rich in LA that is concentrated in an evaporator and sent to the polymerization stage.

Lactic acid polymerization. The concentrated LA stream is fed to a prepolymer reactor, where it forms low-molecular-weight PLA and water, which is removed and disposed. The low-molecular-weight PLA is sent to the depolymerizer and broken into lactide molecules (the cyclic lactone di-ester derived from lactic acid), which are purified in a drying column and in a meso-lactide removal column. Lactide is fed to a polymerization reactor, forming PLA, which is sent to a devolatilizer to remove unreacted lactide. The PLA is routed to an extrusion step and then packed in bags for storage.

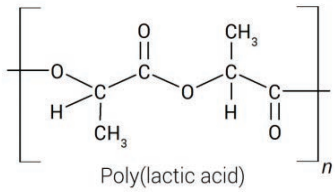


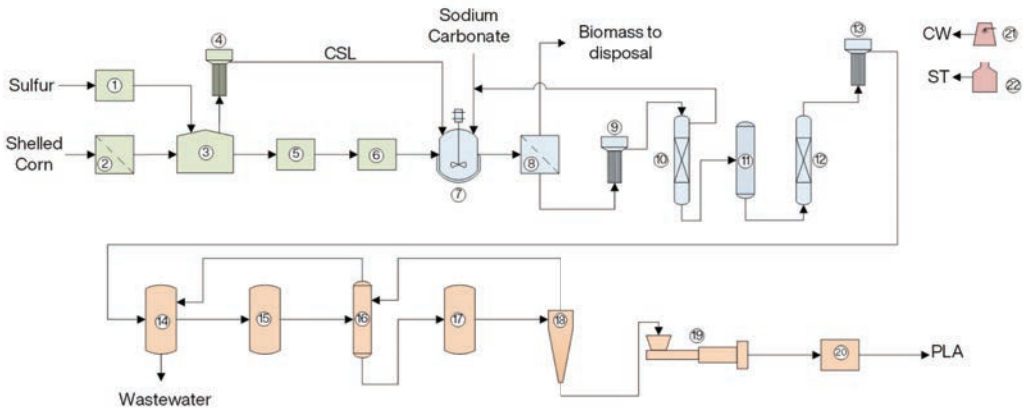
FIGURE 1. PLA is an aliphatic polyester derived from renewable starting materials

Production pathways

This biodegradable polyester can be synthesized via two major routes. The main production route for high-molecular-weight PLA is based on an initial polycondensation of lactic acid, followed by a depolymerization at reduced pressure and a ring-opening polymerization step. The other route is based on a direct polymerization of lactic acid by polycondensation. Most companies employ the indirect route, since the production of high-molecular-weight polymers is difficult via direct polymerization. ■

Edited by Scott Jenkins

Editor's note: Content for this column was originally developed by Intratec Solutions LLC (Houston; www.intratec.us) and is edited by *Chemical Engineering*. The analyses presented are based on publicly available and non-confidential information. The content represents the opinions of Intratec only. More information about the methodology for preparing the analyses can be found, along with terms of use, at www.intratec.us/che.



1. Sulfur burner
2. Grain cleaners
3. Steeping vessel
4. Steep water evaporator
5. Starch recovery
6. Starch hydrolysis
7. Fermenter
8. Ultrafiltration
9. Broth evaporator
10. LA extractor
11. Extractive distillation
12 LA back extractor
13. LA evaporator
14. Prepolymer reactor
15. Depolymerizer
16. Lactide purification
17. Polymerizer
18. Devolatilizer
19. Extruder
20. Packaging
21. Cooling tower
22. Steam generation

CW Cooling water
ST Steam

FIGURE 2. The diagram shows the production process for PLA, starting from corn

Enhancing Plant Safety Via Virtual 'On-Site' Visits

New developments in augmented reality can help plant operators fix critical issues while limiting the number of outside visitors entering the facility

Stacey Phillips
Swagelok Company

IN BRIEF

Reducing risk is an important goal for any plant or petroleum refinery to maintain the health and safety of its workforce. But today, reducing risk carries an additional meaning — protecting all plant workers from potential exposure to the coronavirus.

Over the course of 2020 and now well into 2021, doing so has required limiting face-to-face interactions and maintaining social distancing among plant personnel and site visitors. Plants may additionally have hard limits on the number of people who are allowed inside at a given time. For these reasons, any measure that can help limit human-to-human contact while enabling an operation to maintain consistent, quality production is a beneficial development.

FIGURE 1. Field engineers commonly coordinate with facility engineers on-site when inspecting, servicing, and troubleshooting fluid and sampling systems

FIGURE 2. The use of augmented reality (AR) technology to remotely bring additional engineers into a facility helps to reduce the number of on-site personnel, while enabling a full team to provide support

In the world of the chemical process industries (CPI), implementing these measures is not always easy. On-site visits from contractors, teams of engineers, or other advisors are often an essential part of a plant's operations, whether the visits are associated with fixing broken equipment, troubleshooting malfunctioning fluid or sampling systems, or generally enhancing procedures for better outcomes (Figure 1).

Consider a typical site visit for evaluating fluid systems and analytical equipment at a natural gas processing facility. A team of four or more engineers from an external partner would typically attend this evaluation, walking through the plant together to conduct a thorough evaluation of analytical instruments and areas of concern throughout the facility. Multiple engineers are typically required for this sort of visit to ensure all areas of expertise are covered, as well as to expand the base of field knowledge when determining potential solutions. Due to the breadth of expertise involved, this team approach to site visits can help to improve outcomes.

However, given new necessary restrictions to maintain social distancing, many plants have become reticent to allowing large groups to visit the facility for inspections. Outside engineering teams do have

FIGURE 3. A field engineer wearing an AR headset clipped to her safety helmet inspects critical fluid system equipment at a chemical plant with the help of an engineering team watching a livestream video of her actions and providing remote troubleshooting input

FIGURE 4. A field engineer performs a gap inspection of fittings to ensure proper tightening. This is one of the regular activities performed by external service engineers that can be enhanced with virtual technology

the option to send fewer technicians for on-site visits. However, one engineer cannot be an expert in everything. To accommodate the need for reduced on-site personnel, while overcoming the resulting expertise limitations, some field service providers have begun deploying the use of augmented reality (AR) technology to remotely bring engineers into the facility (Figure 2).

The use of this technology can have benefits beyond the scope of the pandemic. Based on our field engineering team's experience, conducting virtual and semi-virtual system evaluations in chemical plants and petroleum refineries, this article describes how AR technology can be deployed in CPI facilities to deliver the same value and benefit operators expect from on-site visits — with fewer visiting engineers. It also explores specific examples of how a lead engineer on the ground at the facility can help solve process and fluid-system challenges with the help of his or her remote, virtual team.

The AR experience

While AR remains a somewhat new technology, it has matured to the point where it can provide a highly realistic experience — one that can meet the needs associated with diagnosing issues in critical process systems, such as process gas chromatographs, analyzers, sampling systems, steam systems, rotating equipment and more.

On a typical semi-virtual visit, a single on-site engineer will arrive at the facility wearing an AR headset clipped to his or her safety helmet (Figure 3). As the engineer goes about inspection duties — for example, performing gap inspections on fittings to ensure proper tightening for leak-tight performance (Figure 4) — he or she can hear the voices of colleagues in an earpiece. That team of remote engineers, which may include experts from around the globe, is able to view a livestream video of everything the on-site engineer sees and does. This enables the chemical plant or refinery to limit field visitors to just one engineer, while supplementing that person's skill with the combined experience of the full team.

Evaluation examples

With the full team at his or her disposal, the sole on-site engineer can get to work. The engineer can zoom the live camera in on various fluid or sampling system components, focusing the attention of the team on certain parts of the system using voice controls (Figure 5). The on-site engineer and remote

FIGURE 5. Using an AR headset, an on-site field engineer can zoom the live camera in on various systems and components using voice controls

FIGURE 6. With a virtual team of specialists providing remote, real-time problem solving and troubleshooting, on-site engineers can readily solve a range of challenges

team can speak directly about present issues and develop solutions in real time.

In most scenarios, it is ideal to have at least one field engineer present on-site to conduct an assessment while supported by a remote, digitally connected team. However, another option is to have someone from the plant don an AR headset and walk through systems with remote field engineers providing realtime troubleshooting. Vendors offering these types of services may be able to ship a virtual headset to a user who can then record video while talking with remote field engineers who provide realtime troubleshooting. Doing so further limits outside plant visitors while still enabling a larger team to participate.

FIGURE 7. Field engineers can perform comprehensive leak testing on critical equipment, helping to eliminate environmental hazards and improve plant safety

Some specific scenarios our field-engineering team has evaluated include the following: ***Virtual commissioning of fluid systems and advising on the construction and testing of analytical equipment.*** The virtual headsets allow technicians to be "present" to provide oversight during key stages in the fluid system implementation process, helping users avoid errors and integrate longer-lasting assemblies into their operations. Executives at select user companies have even joined virtually to experience processes they would not usually be able to witness.

Virtual evaluation and advisory services. When issues with an analytical fluid system come up, the deployment of an on-site engineer backed by his or her virtual team of specialists can help identify and solve a range of challenges throughout a chemical plant via realtime problem solving and trou-

FIGURE 8. During a virtual evaluation, the on-site engineer can share photos and videos with remote colleagues in real time so everyone can brainstorm solutions as a connected team

bleshooting (Figure 6).

Environmental leak testing. Engineers commonly perform extensive leak testing on fittings to check for leaks that may present safety and environmental hazards. Realtime collaboration between the on-site engineer and the virtual colleagues can streamline the process throughout a plant. Safety and cost savings can be achieved by thoroughly addressing leaks (Figure 7).

Virtual witnessing of key procurement processes. Compliance teams can offer plant operators the opportunity to virtually witness manufacturing and shipping practices that may ordinarily require an on-site visit to vendor facilities.

Virtual user visits to manufacturing and fulfillment centers. On-site visits can go both ways, as plant operators or managers may want to visit and evaluate the processes and operations of their vendors. Virtual technology makes this possible, too.

Additional benefits

Whether inviting a single engineer to perform a virtual site visit or managing such visits with existing plant personnel, virtual visits can help to minimize the amount of time a plant's fluid system issues may go undiagnosed or unaddressed — while also limiting personnel to help accommodate pandemic protocols. At the same time, the plant can additionally save on travel-related costs, accommodations, and coordination time associated with larger site visits. In addition, the user may be able to share data and experiences from a documented site visit at one location with other similar enterprise locations to help enhance those operations.

There can be unexpected benefits, as well. For example, AR visits can prove effective when several people watching remotely are all evaluating the exact same thing, at the same time. This enables several engineers to ask questions in real time and collect data more efficiently, compared to simply having one person on-site, or several people on-site all collecting their own data (Figure 8). This streamlined process can enhance the efficiency of making evaluations and diagnoses, as well as gathering supporting data. This can help eliminate the potential need to go back on-site to get data that were forgotten or missed when looking at notes after the initial site visit.

This ability to gain insight into a system and process the information in parallel to diagnoses and recommendations with the entire team at once can be more effective than typical on-site visits that require multiple touchpoints with the user and system after gathering information across the facility. An engineer who has several other colleagues in his or her "ear" to provide reminders about examining certain system parameters, or to ask the operators certain questions, can result in some significant new efficiencies to the inspection and evaluation process.

A virtual team composed of a global network of specialists who can provide insight in real time, take data, and conduct preliminary calculations, can result in a more comprehensive analysis than when one engineer does this on his or her own. This approach combines decades of experience evaluating a system, collaborating in real time, and sharing insight, all virtually.

Maintaining operational efficiency is a top goal for any chemical plant or refinery. While safety measures related to COVID-19 may have created some challenges in this regard, the technology is available to overcome some of those challenges in unique ways — and the benefits can extend well into the future. ■

Edited by Gerald Ondrey

Acknowledgement

All images courtesy of Swagelok.

Author

Stacey Phillips is field engineering manager, Americas for Swagelok Company (29500 Solon Road, Solon, Ohio 44139; phone: +1-440-248-4600; Email; stacey.phillips@swagelok.com; Website: www.swagelok.com. She has been with the company for 13 years and has extensive experience in the field helping chemical plants and petroleum refining operations optimize critical fluid and sampling systems. Phillips hold a B.Sc. degree in biomechanics from the University of Alberta, Canada, and a M.Eng. degree from the University of Colorado Boulder.

Part 2

Advanced Analytics for Process Safety

A look at how advanced analytics facilitates and improves process safety efforts within the chemical process industries (CPI)

Michael Chang
TrendMiner

Simply by the nature of some of the chemicals used and the associated complex processes involved, chemical plants can be hazardous. With the potential exposure to toxic substances, fires and explosions, incidents can range from minor to extremely serious. They can also result in significant plant damage, injuries, and sometimes even loss of life. Furthermore, major chemical manufacturing incidents can also have a catastrophic impact on the surrounding community and environment. Some examples of serious chemical accidents in recent years include the following:

- The Williams Olefins Chemical Plant in Geismar, Louisiana in 2013 [*1*]— A reboiler rupture resulted in a vapor cloud ignition, due to an unknown source of fire or heat that resulted in two fatalities
- Chevron Oil Refinery in Richmond, California in 2013 [*2*] — Personnel accidentally triggered a spark as they worked to remove insulation from an extremely old pipe that was already leaking crude oil, which resulted in a catastrophic explosion
- Danlin Chemical Plant in Thomas, Oklahoma in 2013 [*3*] — A fire from an unknown source engulfed the plant, which caused explosions of pressurized containers
- Jiangsu Tianjiayi Chemical Plant2 in Yancheng Jiangsu Province, China in 2019 [*4*] – A fire from an unknown source spread to pesticides storage containers causing an immense explosion
- Philadelphia Energy Solutions Complex in Philadelphia, Pennsylvania in 2019 [*5*] — The failure of a corroded pipe resulted in a fire that triggered three massive explosions and the release of 5,239 lb of toxic hydrofluoric acid

FIGURE 1. This photo shows two critical ethanol pumps in parallel that deliver a high-pressure recycle stream to a packed-bed reactor [*6*]

Although there can be numerous potential causes for chemical industrial incidents, one cause is equipment failure. The industry continually faces challenges to ensure proper plant process safety and reduce the risk of incidents. Additional challenges facing the industry include improving plant efficiency, increasing product quality and production yield, and reducing energy consumption. The chemical process industries (CPI) can achieve all of these, along with improved process safety efforts, through the adoption and use of advanced self-service analytics.

A new era of safe processing

CPI plants today capture an immense amount of process data, all of which can — and should — be leveraged to better understand chemical processes. Traditionally, when incidents occur, global process experts and data scientists are often brought in. They will then "deep dive" into historical time-series data and construct mathematical models to help local production teams better understand what happened and determine how they can prevent future incidents. This approach can be inefficient, however, as there are rarely enough global experts and data scientists for the amount of work needed. It is also costly and time-consuming.

A more viable and efficient approach would be to equip process experts with the tools to perform the analytics themselves. This is where advanced self-service analytics comes in play. This tool brings significant value as it allows the process experts to do

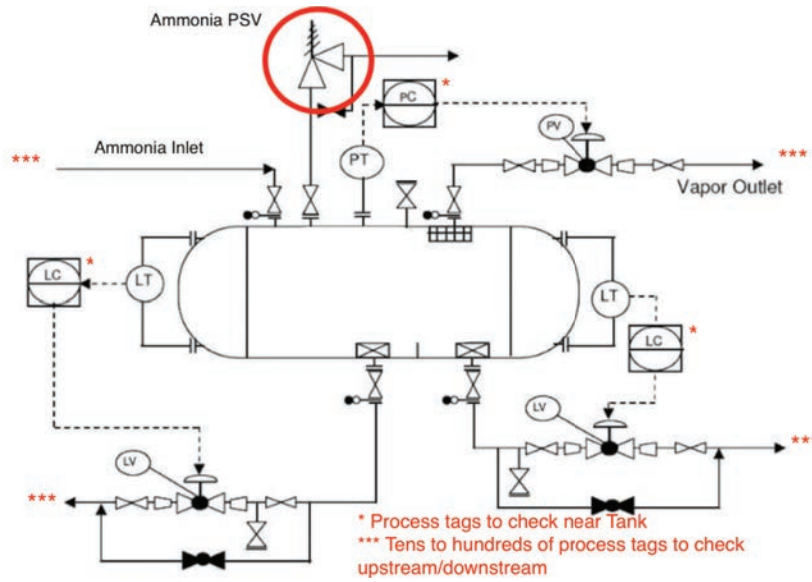


FIGURE 2. This piping and instrumentation (P&ID) diagram details the complexity and extent of troubleshooting required for an accurate root-cause analysis for an ammonia pressure safety valve [7]

the following:

- Analyze and segment historical data quickly
- Perform complex realtime calculations on process data
- Improve knowledge sharing by allowing users to leave comments on process data (to contextualize data)
- Monitor and predict processes within the operational context
- Perform efficient root cause analysis
- Improve asset reliability

After an incident occurs, an incident investigation is usually conducted by operations to understand the root cause and generate action items that would mitigate or prevent future incidents. Traditionally, this has been done by manually scanning through process data in the historian and data wrangling in Excel files to establish a root cause or generate a correlation. Using advanced self-service analytics, root-cause analysis can be performed with significant time savings. With the click of a few buttons, it can search through historical data in a plant's historian for patterns and specific process conditions, quickly locating all correlations between process tags (including lag time). Furthermore, the work can be shared between users, allowing for a bonus of improved collaboration.

Opportunities to improve safety

Advanced analytics offers a number of opportunities for improved safety, including the following:

Efficient process hazard studies. Process hazard analysis (PHA) studies are required by Occupational Safety and Health Administration's (OSHA; Washington, D.C.) Process Safety Management (PSM) and the U.S. Environmental Protection Agency's (EPA; Washington, D.C.) Risk Management Plan (RMP) regulations in the U.S. and serve as the foundation for process safety and risk management programs within chemical plants. PHAs also help protect against product quality issues, process downtime, and property damage. During a PHA session, the process experts often need to locate specific information or process parameters at a given time within the past 5 or 10 years to assess whether a particular process safety scenario is valid. Using advanced self-service analytics, the user can quickly pull up statistical information on and between different process tags and also layer events on top of each other, which facilitates the speed and increases effectiveness of PHAs. Another common task during PHAs is to identify how many times a certain temperature or pressure exceeded a given threshold. Traditionally, this could take hours if not longer to accomplish with multiple people looking at a span that could be 5 to 10 years. However, with advanced self-service analytics, this search can be completed in seconds. Furthermore, advanced analytics can help ensure that no event of interest is missed when assigning risk categories, which assists in the effectiveness and accuracy of PHAs.

Improved asset reliability. Picture a classic asset-reliability use case with two critical ethanol pumps in parallel, which deliver a high-pressure recycle stream to a packed-bed reactor (Figure 1). The primary indication of a leak is a decrease in flow, which sets off a distributed control system (DCS) alarm that alerts operators to a potential leak upstream or a pressure safety valve (PSV) release. However, the outlet flow meters occasionally drift, so operators are not always able to respond quickly enough to swap pumps before a large spill (that is, a process safety incident) occurs.

Using advanced self-service analytics, a realtime theoretical flow can be easily determined, and a deviation alarm can be created to alert production engineers and operators whenever the flowmeter needs to be recalibrated. Furthermore, it can be used to monitor the relationship between differential pressure and flow rate across the pump in real time, which serves as a secondary safeguard to ensure that the pump is operating on the pump curve. As a result, self-service analytics can help mitigate the severity of future process safety incidents related to these two ethanol pumps and also improve asset effectiveness.

Root-cause analysis for an ammonia PSV relief. Another common use case is performing root cause analysis to troubleshoot events that can lead to an ammonia PSV relief (Figure 2). Typically, production engineers would manually search through tens, potentially hundreds of process tags in the historian or DCS looking for a cause that led to a high-pressure relief event. This can take a considerable amount of valuable time and resources.

With advanced self-service analytics, a single engineer or operator can quickly conduct a pattern recognition search on historical data to capture all instances of pressure transmitter reading spikes that led to the PSV relieving. Furthermore, advanced self-service analytics can analyze correlations between the pressure process tag and all process tags available in the historian, and account for time shifts between process tags. Once the process expert selects a process tag of interest as the root cause, it can be visualized and monitored in the future to minimize the poten-

tial for a PSV relief. The speed at which process safety root-cause analysis and incident investigations can now be performed using advanced self-service analytics is simply groundbreaking.

Concluding remarks

No one who works in or around a chemical plant ever wants to experience an incident. Safety is paramount in these plants and processes. Any tool or technology that can help facilitate and improve safety has great value in the CPI. Advanced self-service analytics can facilitate and improve process safety efforts, equipping manufacturing personnel with tools that result in process optimization, improved asset reliability, and even more effective process safety efforts. This is in line with what Huntsman, a leading global chemical company, has experienced. Advanced Analytics Manager and Global Excellence Team member for Huntsman Polyurethanes, Jasper Rutten, has stated, ". . . advanced analytics provides us with 24-hour engineering support, so we are able to optimize processes and asset reliability and to run our plants more stable . . . a more reliable and stabler site is a safer site." ■

Edited by Gerald Ondrey

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Author

Michael Chang is a data analytics engineer at TrendMiner (3701 Kirby Drive No. 740, Houston, TX 77098; Email: michael.chang@softwareag.com; Website: www.trendminer.com) He started his career in chemical manufacturing, with over six years of experience in operations, technology, process improvement, and environmental, health and safety (EHS) compliance. Having always been passionate about leveraging data to improve yield and troubleshoot manufacturing processes, he continues to drive improvements for the process industry. Chang holds a B.S.Ch.E. and a McCombs business foundation certificate from the University of Texas at Austin.

Keeping Valves Corrosion-Free

In all phases of a valve's lifecycle — from fabrication to decommissioning and storage — corrosion protection is essential

Ana Juraga and Julie Holmquist
Cortec Corp.

IN BRIEF

Corrosion can be a serious source of valve damage, and it can often result in costly leakage, failures and repairs or replacements. There are many different types of corrosion, and the risks increase under harsh conditions. A variety of protection technologies are available in the form of physical barriers, coatings and corrosion inhibitors. Some of the best options combine physical barriers to the environment with the use of corrosion-inhibitor technologies to protect intricate and recessed areas that are difficult to access. Such inhibitor technologies make corrosion mitigation much more efficient and effective to benefit valve manufacturers and plant operators. When used in conjunction with simple restoration techniques (Figure 1), these methods play an important role in keeping valves corrosion-free. While valves are critical across the chemical process industries (CPI) — and play a role in every industrial plant, for that matter — it is not just during installation and operation that they need to be corrosion-free. While this is vital for good, reliable processes, corrosion protection starts much earlier and is, in effect, important at almost every phase of a valve's lifecycle. This article explores why corrosion considerations matter and shares practical examples of how the corrosion problem can successfully be remedied for the benefit of all stakeholders involved.

FIGURE 1. Valves are shown before undergoing restoration and preservation activities

Manufacturers must protect valves

Corrosion protection should ideally start at the valve manufacturing plant for the good of both the manufacturer and the recipient. Valve manufacturers face the special challenge of shipping freshly machined valves to the end user in like-new condition. The end user expects to receive them as such, regardless of the climates the valves must travel through to reach the installation site. If the valves arrive rusty, the blame tends to fall on the manufacturer.

Aside from the negative image of receiving a less-than-satisfactory product that is not in peak condition, the end user may legitimately be concerned about installing the parts for fear that rust will cause further problems and potential failure in the future. An expected response would be for the end user to complain and demand rework, replacement or refund. Even if the manufacturer comes through successfully, it would have been much easier to avoid corrosion in the first place rather than suffer the loss of time, money and customer trust that followed.

One of the challenges for doing so is that valve manufacturers often have to battle with a variety of different conditions, including some that are potentially severe, depending on their manufacturing environment and path of export. The particulars of the export route or climate may not even be known very far in advance. However, a general knowledge of the potential exposures can be helpful in executing a preemptive corrosion protection plan to avoid problems down the road.

Manufacturers located in hot, humid environments probably already know from experience that their goods are especially susceptible to corrosion-related damage.

INDUSTRY EXAMPLES

Once the basic concerns and protective mechanisms are understood, it is helpful to see examples of restoration and preservation of valves in action. These examples include a variety of situations that demonstrate how preservation methods can be similar, yet different from project to project.

Longterm preservation solution

In 2017, an API-accredited (American Petroleum Institute) valve manufacturer in Dubai needed a corrosion-protection technology during hydrostatic testing. Due to the harsh climatic conditions, the valve manufacturer was having a significant problem with flash rust and needed a way to remove this preexisting rust. The manufacturer also desired a corrosion inhibitor coating that could be used to preserve the valves for extended periods of outdoor storage prior to commissioning. A VCI hydrotest additive was selected that would deposit a thin protective film during hydrotesting and offer both contact and vapor-phase protection. Bio-based chemistry was chosen for rust removal and neutralized with a flash-rust-inhibiting cleaner. A waxlike removable coating was recommended for outdoor storage and further protection against salt, humidity, ultraviolet light and other harsh weather elements [*2*].

Restoring valve bonnets after over five years in storage

In India, an energy-technology company had valve bonnet spares that were rusted after more than five years of storage. Corporate policy did not allow rust removal with phosphating or other harmful chemical processes, so a bio-based rust remover was applied and then neutralized with an alkaline cleaner. The valve bonnets were restored in 45 minutes and ready to use [*3*].

Protecting spare valves during facility startup

A newly constructed oil-and-gas facility in Alaska experienced problems with corrosion even in the first month, as it received a large influx of spare parts. The harsh environment and long delivery times were to blame, and valves were among the items affected. These were protected for future use by internally fogging them with VCI. Machined faces were protected with a waxlike removable coating. The package was completed by wrapping the entire valve in outdoor-grade VCI shrink film. Any spares needing rust removal were soaked in a bio-based rust remover prior to protection [*4*].

Restoring and protecting valves and other equipment

In 2018, an oil-and-gas company in Indonesia called in a consultant to help it solve a corrosion problem on critical equipment, such as valves and flanges. Some of the equipment had already been used and first required restoration. Because of this, the consultant broke the process into two steps: (1) surface preparation; and (2) preservation. Mud or dried soil was cleaned off using a biodegradable, low-pH organic-salt cleaning alternative to phosphoric and nitric acid cleaners. A bio-based acidic rust remover was used on existing corrosion, followed by rinsing with an alkaline flash-rust-inhibiting cleaner. Preservation of the different components varied depending on the needs of each item. Removable coatings were applied to some surfaces, while VCI was fogged into voids. Lastly, the valves and other parts were wrapped in VCI films. The cleaning procedure was especially efficient and did not require mechanical grinding or blasting. Preservation of the first container of equipment finished in November 2019, and the company was involved in processing a second container of equipment using the same methods in 2020 [*5*]. ❑

Often, manufacturing facilities or warehouses are not air-conditioned, and these hot, humid environments can wreak havoc in the form of flash rust that blossoms on freshly machined surfaces as the valves await shipment or the next step in the manufacturing process.

Once in shipment, whether by land or by sea, the valves face another challenging time when they are at heightened risk for corrosion from fluctuating temperatures, condensation and possibly even exposure to high-chloride-content sea spray. The longer the valve has to remain in these conditions, the worse the results can be. Manufacturers must therefore consider the potential situation and take appropriate precautions to avoid spoiled goods.

FIGURE 2. Wrapping valves prior to storage can help prevent corrosion-related damage prior to storage or shipment

Corrosion at new facilities

Another time that valves face a special risk of corrosion is when they arrive onsite at a new facility under construction. This process of construction and gradual startup can take years, during which time, custom and standard equipment and components are delivered. Chances are high that many of the pieces will be stored on the grounds until all components arrive and construction and installation can be completed. To avoid possible rusting problems during storage, precautions can be taken by the supplier, or by the user onsite (Figure 2).

Keeping critical spares ready

Even after a plant is up and running, a similar rust-prevention responsibility falls on the facility. Best practices call for making sure that critical spares are always on hand to replace a failed component quickly with as little downtime as possible (Figure 3). If the spare valves in storage have rusted, this process will be interrupted, whether from simply having to restore the valve or not being able to restore it at all. Depending on the criticality of the valve, this could have an impact on valve safety in addition to repair expenses and losses from stalled production — a price tag that can quickly add up, especially at chemical processing facilities. If valves are properly restored and preserved ahead of time, the facility can quickly get back to service using these emergency backups that are rust-free and ready to use.

Preserving assets in storage

The decision to shut down a plant is often combined with plans to preserve valuable assets until the time

FIGURE 3. Spare valves should be neatly restored and preserved for future use while in storage so that they are ready to go when needed

that the facility can be reopened or the assets sold. If the valves are allowed to rust, either in place or in storage, there could be serious repercussions. The equipment may not work when it is put back into operation, or there may be a sudden failure down the road. Here, the basic goal is the same as with spares in storage — to preserve pieces in good working order to avoid loss of value.

Restoration and preservation

There are two key aspects to making sure that valves are corrosion-free and ready to go. The first is restoration for valves that have already rusted during the manufacturing, shipping or storage phase. The second is preservation of valves that have either been restored or have not yet rusted. Manufacturers will also likely deal with hydrostatic testing in the preservation process.

Restoration. There are different ways to remove existing rust on valves. A common method is abrasive blasting or grinding, which could be especially challenging on intricate valve internals. Another option is to use water-based or even bio-based rust-remover concentrates or gel. These can be applied by dipping the valve into the liquid or brushing on the gel, leaving it to sit for 20 minutes to an hour (or even overnight, depending on the severity of the rust), then neutralizing and rinsing it with an alkaline cleaner that contains flash-corrosion inhibitors (Figure 4). Once the valve is restored, it can be preserved or installed as needed.

Preservation. Leakage is one of the first preservation concerns that valve manufacturers often need to address. Hydrostatic testing is used to check for leaks. While this procedure introduces moisture to the valve, which can heighten corrosion risks, appropriate corrosion-inhibiting additives can be used to prevent this. Since disposal of the hydrotesting water can present challenges when levels of chlorides, sulfates or other chemicals exceed wastewater discharge limits, it is important to evaluate the disposal profile of the hydrotest additive before adoption.

It is also beneficial to choose a hydrotesting additive that can do double duty for ongoing corrosion protection. For instance, some film-forming hydrotest additives leave behind a corrosion-inhibiting film that protects metals through direct contact and also release corrosion-inhibiting vapors (also called vapor corrosion inhibitors, or VCIs), which offer added protection for metals in hard-to-reach spaces inside the intricate valve internals. VCIs offer some advantages when compared to standard methods of corrosion protection, because the protective chemistry is able to diffuse through void spaces and adsorb onto metal surfaces in an invisible protective layer that interrupts the normal corrosion reaction, yet naturally evaporates when the enclosure is breached, so that special removal

FIGURE 4. Cleaning is an important step in protecting valves against corrosion

of the product is often not required.

It is observed that when valves are only treated with "contact" corrosion inhibitors, the intricate and complex geometry inside them is at greater risk for corrosion. In addition to hydrotesting with a VCI additive for up to two years of protection, experts may suggest fogging a waterborne VCI inside the valves and coating the stems and flanges with an unobtrusive water-based coating rust preventative that may not need to be cleaned off. After this, valve flange guards can be added and the entire valve wrapped in VCI film [*1*]. The same basic protective components can be adopted in almost any phase of production, storage and shipment, depending on the specific user needs or preferences. ■

Edited by Mary Page Bailey

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Authors

Ana Juraga (Email: ana.juraga@ecocortec.hr) has been a content writer at Cortec Corp. for 10 years. Besides dealing with media relations, she collaborates with Cortec's engineers and chemists in creating informative technical content. She is passionate about educating the engineering community about green corrosion-inhibiting technologies and advancements in this field.

Julie Holmquist (Email: jholmquist@cortecvci.com) has been a content writer at Cortec Corp. for more than five years. She specializes in writing about corrosion-inhibiting technology for concrete, electronics, manufacturing, oil and gas, and many other industries. Her articles have been published in dozens of industry magazines.

Specifying Severe-Service Valves for Urea Applications

To withstand the harsh conditions and potential safety risks encountered in urea agricultural applications and other severe-service processes, special consideration must be given to valve construction, performance and installation

Don Bowers
Conval, Inc.
Jennifer Jones
Armour Valve Ltd.

IN BRIEF

Severe-service valves (SSVs) are specially designed and manufactured for critical applications in which the potential consequences of valve failure include serious and costly risk to life, plant operation and property. SSVs are typically exposed to relatively high pressures and temperatures, as well as corrosive or lethal media.

A significant chemical industry application for SSVs is the production of urea (Figure 1). Globally, over 90% of the urea produced is used as an economical form of nitrogen fertilizer for agriculture (Figure 2). With the world's estimated population of eight billion people and growing, global demand for food, and therefore fertilizer, is strong and resistant to economic cycles. According to Expert Market Research (EMR), the global market for urea in 2020 was 187.8 million metric tons. By 2026, that number is expected to grow 12.61%, to 211.5 million metric tons.

Another application for urea is the reduction of air pollution from diesel engines, which run at high temperatures and produce high concentrations of nitric oxide. Urea tanks are now standard equipment in many new diesel trucks, buses and cars.

Urea synthesis

Urea is produced by the reaction of ammonia and carbon dioxide typically at high pressure (140 bars; 2,031 psi) and temperature (183°C; 362°F). There are different processes that have been developed to synthesize urea. One of those involves a urea reactor, stripper, high-pressure carbamate condenser and high-pressure off-gas scrubber (Figure 3). In the reactor, CO_2 and NH_3 are partially converted into urea and water. The stripper separates the residual CO_2 from the NH_3, which is further processed through the high-pressure carbamate condenser. The scrubber separates residual inert gases, such as oxygen and nitrogen. Note that ammonium carbamate, an intermediate product, is highly corrosive.

Severe-service metallurgy

When specifying severe-service valves for urea service, the most important aspect to understand is the uniqueness of the required metallurgy. These processes generally function best when the oxygen content is kept to a minimum, yet many alloys require oxygen to be present in order to form and maintain corrosion-resistant surfaces. Over the years, there has been an evolution of alloys that were selected by the urea industry for their ability to function in these processes at increasingly lower levels of oxygen. Early on, austenitic stainless-steel alloys, such as 316L-Urea Grade (316L-UG or UNS S31603), 316L LN (UNS S31653 or EN 1.4429) and 25-22-2 (UNS S31050), were used with varying degrees of success. However, as even lower levels of process oxygen became more vital, Duplex (DSS) and Super Duplex (SDSS) stainless steels were introduced, which permitted

FIGURE 1. Urea manufacturing requires that all equipment, including valves, be able to handle severe conditions and exposure to harsh media

FIGURE 2. Granular urea fertilizers are widely used across the globe and their demand is expect to grow considerably in the next five years

almost zero oxygen to be present while providing greater strength. Depending on the age of the facility, process conditions and the licensor of the specific process, alloy selection may vary. It is critical for valve manufacturers providing urea service valves to strictly adhere to the rigorous alloy standards required. To avoid problems, it is best for end users to clearly identify and document the requirements for materials, procurement and inspection.

The International Molybdenum Association (IMOA; London, U.K.; www.imoa.info) provides some of the following practical guidance and useful background on DSS [*1*]:

- DSS alloys have a two-phase microstructure comprised of grains of ferritic and austenitic stainless steel. Figure 4 shows the yellow austenitic phase as "islands" surrounded by the blue ferritic phase
- When DSS is melted, it solidifies from the liquid phase to a completely ferritic structure
- As the duplex material cools to room temperature, about half of the ferritic grains transform to austenitic grains ('islands'). The result is a microstructure of roughly 50% austenite and 50% ferrite

Due to their high strength (around twice that of typical austenitic or ferritic stainless steels), improved corrosion resistance and weldability, DSS alloys are ideal for valves in urea applications and other severe-service processes. These alloys are strong enough to handle pressures in the range of 1,500 to 2,500 psi. Valves for urea service must facilitate self-washing flow and provide no cavities where the build-up of precipitants can occur. DSS and SDSS alloys are also used in piping and tubing because of their strength and corrosion resistance.

These chromium-nickel-molybdenum (Cr-Ni-Mo) alloys contain high chrome content, as well as varying nickel, molybdenum, manganese and other alloying element additives. The Huey test (ASTM A262, Practice C), developed by ASTM International (West Conshohocken, Pa.; www.astm.org), is used extensively to confirm the ability of alloys to withstand the type of corrosion present in urea processes, and the chromium-molybdenum ratio is a reasonable (but not perfect) predictor of likely Huey test performance. The pitting resistance equivalent number (PREN) is another useful measure of corrosion resistance usually relative to corrosion pitting temperature (CPT) and corrosion cracking temperature (CCT), as measured by the Streicher test (ASTM A262, Practice B). PREN typically increases with the chromium, molybdenum and nitrogen content of the alloy. For 316L stainless steel, the PREN is 25. For a typical DSS, the PREN is around 36. For SDSS with chrome content of 25% and more, the PREN can exceed 40. Lastly, the ferrite content of these alloys is generally controlled, and in addition to the Huey test, such test data are often required on certified material test reports for urea alloys.

DSS and SDSS alloys are very expensive to develop and manufacture (Figure 5). One helpful analogy would be custom pharmaceuticals. Some original equipment suppliers to urea plants have secured access to custom alloys developed by licensors and their materials organizations. Other common high alloys used in the manufacture of urea service valves are Ferralium 255, 310 MoLN, Duplex F51, SAF 2507, Super Duplex F53, Zeron 100 and titanium.

Research and development activities related to advancing SDSS alloys' performance are ongoing in industry. Recent product innovations include: the Safurex and Safurex Star grades (developed by Stamicarbon and Sandvik); Uremium29 (developed by Casale and Tubacex); and DP28W (developed by Toyo and Sumitomo).

In most instances, the design of urea service valves is uniquely driven by the requirements of the process and the behavior of the chemicals involved. However, valves should conform to the B16.34 standard developed by the American Society of Mechanical Engineers (ASME; New York, N.Y.; www.asme.org) and all other ap-

FIGURE 3. Typical urea-synthesis processes involve reacting ammonia and carbon dioxide, followed by a stripping step, carbamate condenser and scrubbing

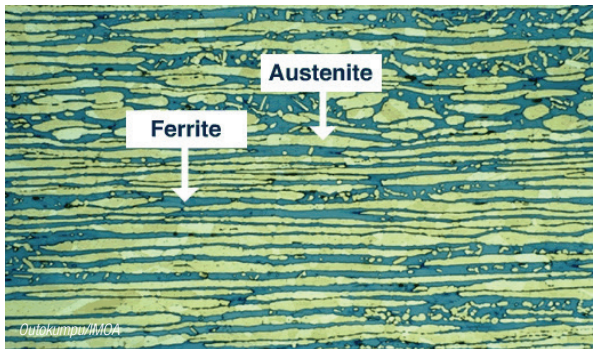

FIGURE 4. This electron microscope image of Duplex stainless steel shows the two-phase microstructure of austenite and ferrite grains

plicable quality/engineering standards from international orgnaizations, such as: ASME; Canadian Registration Number (CRN) certification; European Conformity (CE) certification; International Organization for Standardization (ISO); the German institute for standardization (DIN); and the Pressure Equipment Directive (PED).

From a production standpoint, compared with other alloys, machining DSS and SDSS takes more time in terms of feeds and speeds. These alloys may be welded, but they require close attention to interpass temperature (200 to 300°F maximum). Care must be taken to limit bead thickness. Good welding metallurgy must maintain the proper balance between the austenite and ferrite phases. This can be negatively affected by cooling too quickly, having high ferrite content in the weld metal and having inadequate shielding and purging gas. A proper, open-joint design is necessary. Preheating should be limited to less than 100°F. Major processes may be used, such as shielded metal-arc welding (SMAW), tungsten inert-gas welding (GTAW), gas metal-arc welding (GMAW) and submerged-arc welding (SAW). Standard helium-leak testing must be performed.

Valves for urea handling

Due to the relative high cost of DSS and SDSS alloyed valves, piping and tubing, as well as the complexity and high cost of welding, it is wise to specify long-lifecycle valves that are easily accessible for maintenance, repairs and renewal.

When using such inline renewable valves (Figure 6) in urea service, the troubleshooting and repair process is much simpler, faster and more economical. Once the valve is repaired, no welding is required to return it to service. Thus, inline valve renewability often results in enormous savings in downtime, labor and materials. Such valves are available in many configurations, including ball, globe, check and gate valves. The following are some additional general considerations for specifying valves in urea service applications:

1. Understand the challenges of the application as it relates to the valve capabilities, the process flow conditions, corro-

FIGURE 5. Duplex stainless steel (DSS) is created in a foundry. Because DSS is a high-performance specialty material, it can be expensive to produce

sive media and the valve mode of operation (manual, gear, motor, pneumatic and so on).

2. Recognize and adhere to applicable national and regional codes and standards, in addition to any site-specific requirements.

3. Know where in the plant or process the valve is to be installed and the degree of need for specialty material. Note that not all applications will require specialty materials. Understanding such requirements will help to avoid unnecessary additional costs associated with specialty materials.

4. Acknowledge that urea-handling processes are severe-service applications that are subject to corrosive media and high pressures. The nature of urea applications can lead to the need for repair, so valves should be easily maintainable, preferably in-line. Replacement parts should be easy to order with prompt delivery. Repair should not be complicated.

5. There needs to be flexibility in valve design when replacing older valves (for instance, matching face-to-face dimensions that are proprietary or not to current standards).

6. Confirm and verify the materials being supplied via certified material-test reports and required inspections from accredited bodies.

7. Urea facilities are not identical to each other, but there is some commonality. Being able to apply lessons learned from one site at another can be helpful.

8. Make sure that your valve source provides excellent customer support, providing timely and professional advice, testing and service.

9. Stay informed about best practices in SSVs in order to make the wisest possible SSV specification choices possible. ■

Edited by Mary Page Bailey

FIGURE 6. This ball valve is configured with top-entry accessibility and in-line renewablility, both of which are useful in urea service

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Authors

Don Bowers is the vice president of Conval Inc. (96 Phoenix Avenue, Enfield, CT 06082; Email: dbowers@conval.com, Phone: 860-749-0761; Website: www.conval.com), a manufacturer of severe-service valves for demanding industrial applications. Bowers' experience and knowledge base spans almost four decades in the thermal-power and severe-service valve industry. His career has included positions at Graver Energy Systems, Bechtel Power, Crane, Velan, Weir and Conval. He is a member of ASME; chairman of ASME Standards Committee IX; a member of the ASME SCIX's Subgroup General Requirements and Subgroup Welding Qualifications; and past chairman and member of the National Board Inspection Code's Subcommittee on Overpressure Protection (NBIC-SCOP). He also serves on the Valve Manufacturers Association's *Valve Magazine* Editorial Review Board.

Jennifer Jones is the urea industry market lead at Armour Valve Ltd. (126 Milner Avenue, Toronto, Ont., Canada M1S 3R2, Email: jjones@armourvalve.com, Phone: 416-299-0780, Website: www.armourvalve.com), a Canadian provider of industrial valves, specialty equipment and support services to industrial users. Jones is a Professional Engineer with over 20 years of experience in technical sales. She started her career in Armour Valve's Inside Sales department, which gave her an understanding of the technical and commercial factors that that impact product selection. In her current role as strategic accounts & pricing manager and as Armour Valve's market lead for the fertilizer industry, she works with end users, consultants and manufacturers to provide optimal solutions for critical applications.

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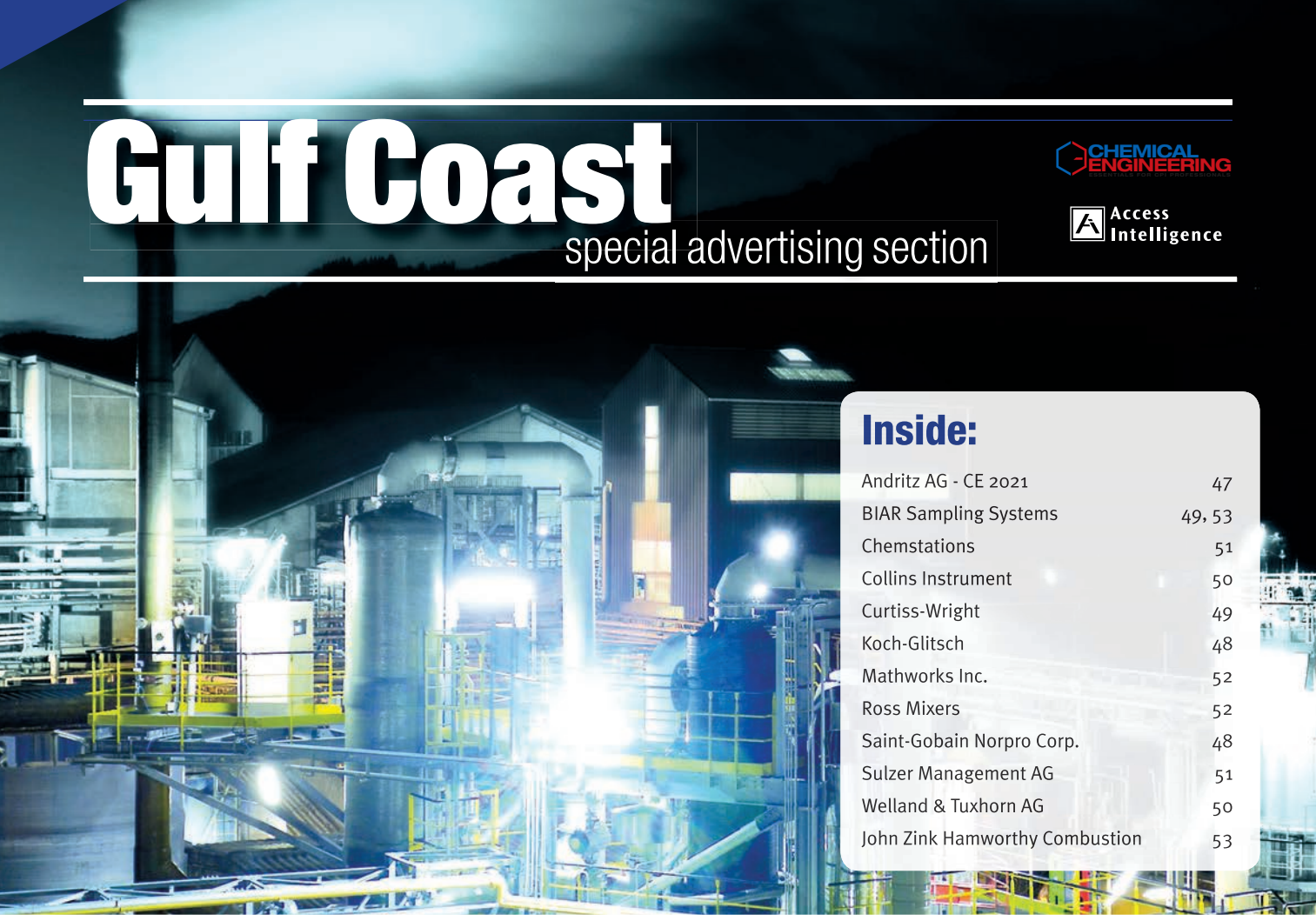

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TOWER VIEW software uses process simulation software coupled with proprietary Koch-Glitsch models to accurately calculate tower hydraulics in real time.

Sampling for Sulfuric Acid Alkylation Unit

A sulfuric acid alkylation unit (SAAU) in a refinery is the process by which isobutane is combined with light olefins over a sulfuric acid catalyst of 87-92.5% strength to produce high octane gasoline. The alkylation process results in reduced sulfuric acid strength, which must be monitored closely to prevent acid runaway. To prevent this, fresh concentrated sulfuric acid is added to the process. For a unit to operate as efficiently as possible, Operations must make sure that acid levels are maintained above the required strength for the process while also minimizing acid consumption, as sulfuric acid is one of the major costs of the refinery. Such a balancing act, between safety and efficiency, can be difficult to manage in real world situations where conditions can change quite rapidly. An inline system that is engineered to address the most common issues found with traditional sampling methods is the key to higher productivity and efficiency, improved safety, and a plant's bottom line.

Safety: As sulfuric acid is toxic and extremely corrosive, the sample system should be designed to ensure exposure is kept to an absolute minimum. Sulfuric acid will react with moisture in the atmosphere and produce a highly visible acid mist which can lead to severe irritation of the eyes and respiratory tract in high concentrations. While collecting the sample, the operator must be protected from acid fumes at all times.

Ease of use: The sampling process should be made as simple as possible so that the room for error is greatly reduced or eliminated entirely. This means that there should be as few procedural steps as possible to grab a sample. Sampling systems which feature numerous connections and tubing are not very robust, and also present potential leak points.

Representative samples: Accurate samples are a critical factor in determining acid strength. If the sample is influenced by product left in the process line, a representative sample is difficult to achieve, particularly if the line has to be flushed or purged before a sample is taken. This process also produces waste which must be neutralized, and represents a significant cost to the refinery.

The most effective way to mitigate the risks associated with sulfuric acid is to isolate people from the hazard using engineering controls. An inline solution offers the safest, most robust, reliable and cost effective solution for grab sampling sulfuric acid to monitor acid strength in a sulfuric alkylation unit.

Contact **BIAR Sampling Systems** to discuss your Sulfuric Acid Alkylation Sampling requirements and download our whitepaper on Sampling Sulfuric Acid

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Keeping Turnarounds on Track with a Reliable Plugging Solution

Pop-A-Plug® Tube Plugs from Curtiss-Wright EST Group

Pop-A-Plug Tube Plugs maintain a leak-tight seal without causing damage to tubes or tube sheets

Many turnarounds may be scheduled months in advance, yet plants still struggle to meet start-up and completion dates. By some industry estimates, up to 90% of turnaround projects extend beyond their scheduled time. Delays of even a few days can add millions of dollars to the cost of a turnaround when factoring in reduced productivity of the facility and additional on-site contractor labor.

For over 50 years, **Curtiss-Wright's EST Group** have been designing and manufacturing products and systems to simplify maintenance to shorten turnaround times for operation-critical equipment, from shell-and-tube and air-cooled heat exchangers to pipelines, piping systems, and pressure vessels.

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Shell-and-tube heat exchangers represent one of the most common and critical pieces of process equipment in plants. In most environments, heat exchanger tubes eventually degrade or leak as a result of prolonged runs, impurity-induced fouling, and corrosive fluids that run through the system.

One traditional process of sealing tubes involves installing tapered plugs, often welded into the tubes with pre-heat and post-weld heat treatments. This process is both time-consuming and unreliable. Tubes and tube sheets may suffer from circumferential cracking after units are brought back into service from pressure and temperature cycles that are common during normal operation. Curtiss-Wright EST Group's heat exchanger plugging system greatly minimizes delays in equipment maintenance during turnarounds by eliminating welding altogether.

The system includes **G-160 Tube Testing Tools** for leak detection in shell-and-tube heat exchanger, boiler, and condenser tubes. These tube testers can rapidly pinpoint tube leaks while providing a safer environment for plant personnel with their patented gripper technology.

Once leaks are identified, **Pop-A-Plug Tube Plugs** deliver a permanent and cost-effective plugging solution. Plugs install hydraulically using a unique breakaway, eliminating the labor and time associated with welding tapered plugs into place. Installed properly, Pop-A-Plug Tube Plugs maintain a helium leak-tight seal without causing damage to tubes or tube sheets. They can withstand extreme thermal and pressure cycling at working pressures up to 7,000 PsiG (483 BarG), and meet ASME PCC-2 (Article 3.12) recommendations for the inspection and repair of shell and tube heat exchangers.

Pop-A-Plug Tube Plugs are available in wide range of materials, including corrosion-resistant alloys, matched to the metallurgy of the unit in which they are to be installed. Matching plug and tube material mitigates thermal expansion/contraction issues, and undesirable galvanic corrosion, ensuring the leak tight seal.

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The differential-area piston eliminates the necessity for auxiliary loading regulators. All actuator parts apart from the integral positioner are molded of glass-filled, UV-inhibited polypropylene. Before shipment, the aluminum positioner and a portion of the cylinder are immersed in Dip Seal to provide atmospheric protection.

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The integral positioner eliminates the need for external linkages which are subject to corrosion and malfunctioning. Valves may also be furnished without a positioner for on/off applications.

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Along with its corrosion resistance the Collins control valve features a stem packing arrangement that virtually eliminates the problem of fugitive emissions, thereby protecting the environment.

Located on the Texas Gulf Coast in the town of Angleton, Collins Instrument Company has been serving the chemical and petrochemical industry for over 65 years. **www.collinsinst.com**

Optimizing crude oil distillation equipment: Sulzer's separation technology supports even the most ambitious refining process intensification projects

To remain competitive, businesses in the oil and gas sector should invest in technologies that can help them improve processing performance while reducing production costs. Choosing a reliable partner for cutting-edge mass transfer components, such as Sulzer Chemtech, can help to significantly boost refining operations.

Sulzer by Chemtech supports oil and gas companies in the downstream sector by designing, manufacturing and installing high-performing, state-of-the-art separation systems. The company's comprehensive range of technologies increases equipment's service life, column capacity and separation quality by tackling the biggest operational issues in refineries. These include foam formation, fouling caused by salt deposition or sand/catalyst particles, corrosion and coke formation.

One of the most common issues in preflash columns is foaming. Refineries can rely on Sulzer's innovative solutions, such as an Inlet Cyclone or GIRZ, to mechanically control and break foam as it forms without the use of chemicals. These cyclones are positioned on the column inlet and utilize centrifugal force as well as the momentum of the feed stream to separate its phases. As a result, the gaseous phase is released from the top, while liquids accumulate at the bottom of the device. This in turn reduces production costs and maintenance activities while improving product purity.

The Inlet Cyclone also plays a role in preventing fouling and corrosion of the column. When combined with Sulzer's specialized column trays and valves, refineries can further minimize these issues as well as reduce coke settling. For example, special anti-fouling valve trays, such as the VG AF, have excellent fouling resistance, increasing the overall system reliability, while improving the column performance.

As a full-service provider, Sulzer offers a wide range of dedicated engineering services that can help refineries and petrochemical complexes to optimize their processing activities and increase plant productivity.

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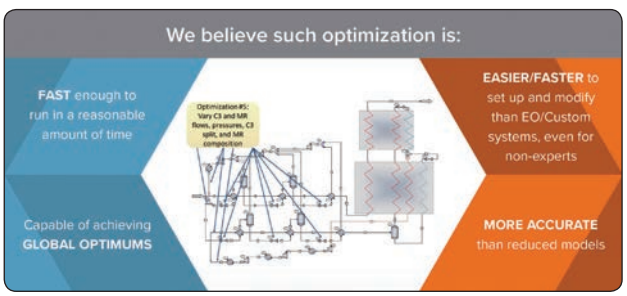
Since 1988, **Chemstations** has been a recognized leader in chemical process simulation software, and the company has continuously improved CHEMCAD on both the software architecture and chemical engineering functionality levels.

Hidden in every chemical process is money, improved efficiency, and reduced environmental impact. To date, however, optimizing even well-known processes is a daunting task. Using rigorous models, reaching an optimum could take months or more of calculation time. So, companies often cut back the number of variables in an optimization, chose to use a non-rigorous model, or turned to custom-written, fast-executing code. This means the tradeoffs are either (1) having no idea whether a global optimum is found, or (2) spending large sums of time and money to build custom optimizations.

Computing power has increased (Moore's Law) significantly since the early days of process simulation. However, CPU clock speed isn't the driving factor anymore; it's number of cores. The ability to parallelize calculations to all the available CPU cores, as CHEMCAD NXT can, is the key to running orders of magnitude faster than before.

Using CHEMCAD NXT's Simultaneous Modular SQP Optimizer (which includes mixed integer variables), companies can build optimizations right into simulations they are already using for their work. Most chemical engineers are familiar with flowsheeting in a simulator, and most also understand the principles of optimization.

Engineers also need confidence that the optimum found by the model is the global optimum. CHEMCAD NXT handles this by parallelizing a large number of starting positions. Multiple restarts are performed until several solutions converge within set tolerances. Therefore, CHEMCAD NXT's calculation speed increases the odds



of finding the global optimum in a reasonable amount of time and each simulation run is extremely fast.

The improvement in run-time for a complex optimization is on the order of 7X-10X faster from single-threaded to 6-core calculation. Machines with more cores will give relatively similar performance increases, depending on simulation complexity (less complex simulations will reach a plateau in performance).

The CHEMCAD NXT team is working with customers on new and exciting applications at all process scales, and the early feedback is that (1) experts in process optimizations will be able to take on more projects in a given time frame, and, possibly more importantly, (2) even non-experts can tackle optimizations and feel comfortable that the results are accurate and actionable.

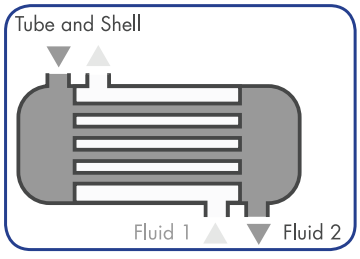
Visit chemstations.com/NXT2 for a more detailed example.

Predict Heat Exchanger Fouling

Reduce the downtime of heat exchangers by building predictive maintenance programs and digital twins with MATLAB

Cleaning heat exchangers is expensive. Maintenance can cost hundreds of thousands dollars annually. However, operating a fouled exchanger affects the energy efficiency of the process by requiring additional utilities such as steam and natural gas. Hence, it is important to clean neither too often (too costly and higher HSSE risk) nor too infrequently (higher operational cost and low efficiency). Implementing a predictive maintenance program can address these issues. By estimating the remaining useful life (RUL) of exchangers, process engineers can take timely action to both prevent unexpected equipment downtime and reduce unnecessary maintenance expenditures.

Key to developing a predictive maintenance program is having a finely tuned first-principles model for the heat exchanger along with appropriate sensor data. **MATLAB** allows engineers to build models of heat exchangers using prebuilt libraries of equipment. Simulink and Simscape allow engineers to perform rigorous heat and mass transfer calculations and incorporate pressure and temperature-dependent behavior of fluids. They can also assess the effect of temperature on component and process-level performance. By tuning the model to match sensor data using Simulink Design Optimization, engineers can create a physics-driven, up-to-date representation of the heat exchanger in the field. This digital twin is then operationalized to make accurate predictions of heat exchanger performance.



Modeling a heat exchanger in MATLAB.

Once the digital twin is created, Predictive Maintenance Toolbox lets users estimate the RUL of exchangers. The toolbox provides multiple functions and an interactive app for extracting and ranking features for exploratory and predictive analytics. Failure criteria for components, including time, pressure, or temperature-based conditions, can be specified, allowing engineers to track system changes and determine the presence of anomalies and faults. This approach enables the detection of any drift in the operation of the heat exchanger so that operational issues, such as fouling, and off-spec products can be mitigated.

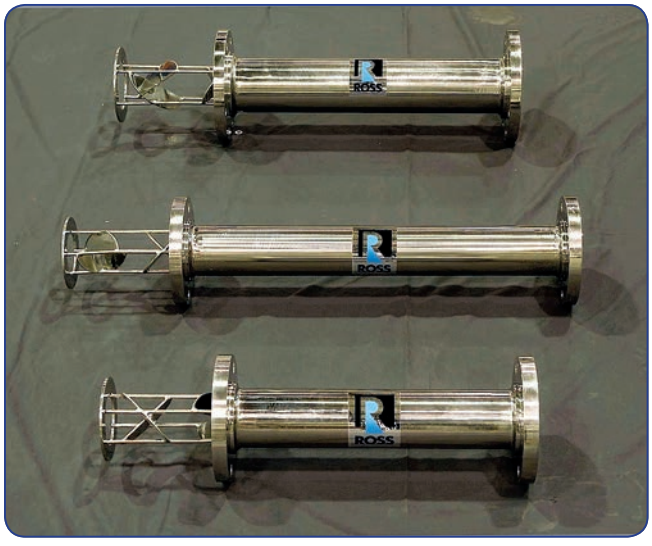
Engineers and operators need to use the validated digital twin in an operational environment. Standalone executable applications and dashboards can be created with App Designer and MATLAB Compiler. This way, models built in MATLAB can be either deployed onto the DCS or shared with anyone via an internal web application without involvement by IT.

www.mathworks.com/solutions/chemicals-and-petrochemicals

A classic mixing tool for the petroleum industry

Ross LPD Static Mixers are rugged, reliable devices that combine excellent inline mixing with minimal pressure loss

Ross Low Pressure Drop (LPD) Static Mixers are used throughout the oil and gas industry for turbulent-flow mixing applications.



Shown are removable LPD mixing elements supplied with retainer ring and flanged housing.

These heavy-duty low-maintenance devices serve in continuous operations where high performance and accuracy are required, such as on-line water determination of crude oil; dosing of various additives into gasoline; blending different kinds of fuel oils; gas-gas blending; and pipeline reactions, among others.

Static mixers have no moving parts and the energy for mixing is available in the form of pressure. Pressure loss – a natural consequence of static mixing – sometimes becomes the deciding factor in mixer selection. The LPD Static Mixer remains a classic choice for many inline blending requirements due to its simple and durable design capable of uniform mixing with little pressure loss. The mixer elements consist of semi-elliptical plates carefully positioned in series to split and rotate the product 90 deg. in alternating clockwise and counterclockwise directions.

LPD mixers in diameters from 1 in. through 2.5 in. are welded to a central rod, while larger elements are welded to four outside support rods for maximum rigidity and stability. Units as large as 48 in. diameter can be supplied as stand-alone mixer elements or as modules complete with a mixer housing and injection ports.

Established in 1842, Ross is one of the oldest and largest mixing equipment companies in the world. Ross mixing, blending, drying and dispersion equipment is used throughout many industries in the manufacture of foods, adhesives, electronics, coatings, cosmetics, pharmaceuticals, plastics and composites.

www.staticmixers.com

Sampling for HF Alkylation Unit

Much like the sulfuric acid alkylation unit (SAAU), the hydrofluoric acid alkylation unit (HFAU) converts olefins to high octane alkylate. One of the main differences between the two is that isobutane is more soluble in HF than H_2SO_4. With optimum operating conditions, 99% of the olefin feed can potentially be converted into alkylate. To achieve optimum operating conditions however, acid strength and water content must be continuously monitored. Lower acid strengths are extremely dangerous and can lead to acid runaway. Low levels of water will result in poor alkylation conditions, while high levels will result in corrosion.

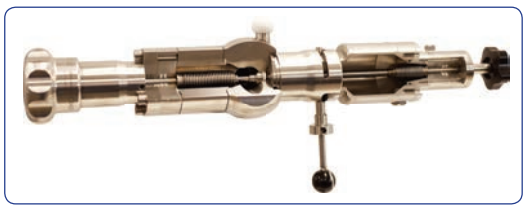
Whether the UOP or Phillips Alkylation processes are being utilized, optimization of the net consumption of HF acid is critical both from a product quality point of view but also from a profitability standpoint.

In the absence of online HF analyzers, grab sampling becomes one of the most important tasks in a HFAU, and it also becomes one of the most dangerous. HF is extremely toxic, and it is vital that there is no risk of exposure to the Operator. Typically, HF acid samplers are located at the bottom of the settlers, on the way back to the reactor.

When we talk about sampling hazardous chemicals, there are really only two main criteria:

- **The sample must be REPRESENTATIVE.**
- **Sampling must be SAFE.**

A system installed directly on the process line or fast loop will not only guarantee a representative sample, it also simplifies the process and has fewer potential leak points.



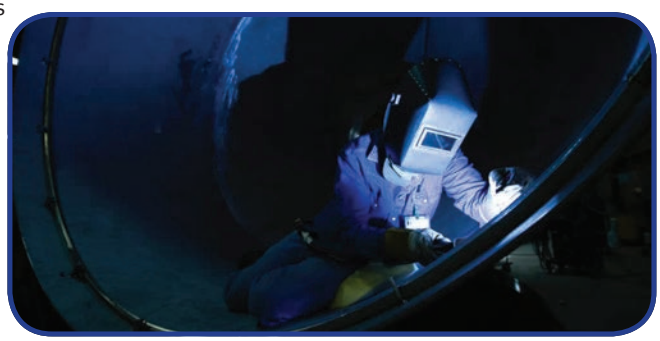
Contact **BIAR** to download our brochure regarding a Simple & Safe Sampling System for HF Alkylation Units

www.biar.us/hfau

Koch Engineered Solutions

Delivering value to customers through innovative engineered-to-order solutions.

Koch Engineered Solutions (KES) is a growing community of experts in more than 25 countries across the globe—more than 5,000 strong—that engineer, manufacture, install, and optimize processes and solutions for refiners, chemical companies, municipalities, and other diverse industries. Whether it's in mass and heat transfer, combustion and emissions controls, separation and ion exchange, materials applications, automation or actuation—KES helps partners optimize performance and develop advantages in the marketplace.



The KES family of companies includes:

- Dark Vision: Ultrasonic imagery technology to transform and improve industrial asset integrity management.
- Genesis Robotics and Motion Technologies: Motors and mechanical innovations that change how robots and machines are built and move.
- John Zink Hamworthy Combustion: A single source for emissions control: ultra-low emission burners, vapor recovery systems and custom combustion solutions.
- Koch-Glitsch: Mass transfer and mist elimination equipment for refineries and chemical plants worldwide.
- Koch Heat Transfer: Thermal and mechanical engineering expertise and solutions for heat transfer processes.
- Koch Knight: Acid-proof products made from state-of-the-art ceramics and plastics.
- Optimized Process Designs LLC: Full-service support and technologies for the natural gas and gas processing industries.
- Koch Project Solutions: Tailored strategies, from project conception to completion, for industrial capital deployment and optimization.
- Koch Separation Solutions: Precision membrane technologies for purifying the world's water supply.
- Koch Specialty Plant Services: A world leader for providing tower, vessel and mass transfer equipment services.
- OnPoint: A portfolio of digital solutions that enable more efficient, optimized performance.
- Sentient Energy: Intelligent sensors and analytics for smarter, more reliable electric distribution grids.

www.kochengineeredsolutions.com

IIoT

special advertising section

Electric actuators for Industrial Ethernet

AUMA actuators support Profinet, EtherNet/IP and Modbus TCP

AUMA electric actuators support the Industrial Ethernet standards Profinet, EtherNet/IP and Modbus TCP, making the multiple benefits of Industrial Ethernet utilisable at field level.

Profinet, EtherNet/IP, Modbus TCP – Industrial Ethernet protocols are increasingly gaining ground for field device integration in the chemical process industries. Offering outstanding connectivity, combined with simple and robust transmission technologies, these protocols are key enablers for enhanced data integration, intelligent analytics and IIoT applications.

AUMA electric actuators support these standards and can be easily integrated in Profinet, EtherNet/IP and Modbus TCP environments, enabling plant managers to fully benefit from the enormous potential to optimize processes and maximize plant availability.

With bandwidths up to 100 Mbit/s, AUMA actuators provide reliable and rapid exchange of both cyclic process data and acyclic diagnostic data from the actuators. The wide range of diagnostic data that is automatically logged by the actuators is immediately available at network level and can be further used for analysis, process visualisation, or simulation, facilitating condition-based predictive maintenance and efficient asset management.

Providing utmost flexibility, the actuators can be integrated into line, star and loop topologies, using different transmission media such as copper cables, optical fibres and wireless technologies. AUMA provides standardised device descriptions as GSDML or EDS files and Field Device Integration Packages, thus facilitating device integration.

www.auma.com

Optimize calibrations

Putting data to work by optimizing calibration intervals

Achieving the correct balance between too much calibration and too little is a challenge for anyone reliant on critical measurements. Many companies follow a static interval approach and calibrate once a year during scheduled downtimes. This fixed calibration interval selection is a typical illustration of established but outdated rules.

Ideally, calibration intervals should be chosen to reflect an acceptable risk that the measurement error has not drifted outside of an acceptable range. Considering common practice, this is seldom the case. Often calibration intervals are set to one year for the sake of convenience as it aligns well with annual planning cycles. However, calibration intervals should be optimized to find the best trade-off between cost and risk.

Using established existing statistical methods as a base, **Endress+Hauser** has developed an enhanced method for calibration interval optimization. With Calibration Interval Optimization Endress+Hauser has developed a service that delivers more than a calculated result. Significant interval changes are discussed, and all underlying assumptions validated together with the customers. Intervals are then included as one of a number of operational constraints including downtime availability to deliver a fully optimized calibration execution schedule. In the end, the customer benefits from an overall reduction of both cost and risk.

This scientific model has been proven across +22 billion calibrations and considers past calibration results to predict future behavior with the following main results:

- 67% of current calibration intervals could be significantly increased
- only 20% of instruments are set up with an optimal calibration interval
- time operating out of tolerance can be reduce by 46% compared to a static approach

Calibration Interval Optimization uses a proven scientific model to determine intervals between calibrations.

It includes:

- Determination of optimal calibration intervals using innovative methods
- Consultancy provided by metrology experts
- Alignment to, and application of intervals according to operational constraints

The benefits:

- Reduction of calibration costs due to extended calibration intervals
- Reduced out of tolerance risk as calibration intervals are reduced

www.endress.com

Economic Indicators

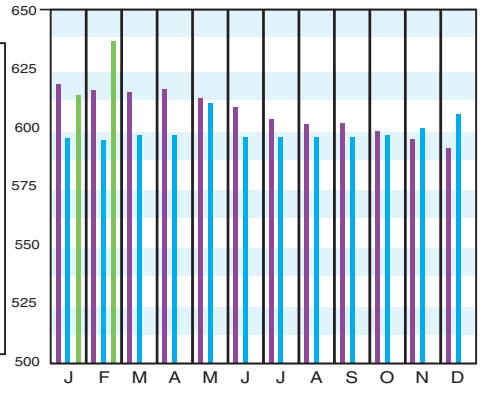
2019 2020 2021

Download the CEPCI two weeks sooner at www.chemengonline.com/pci

CHEMICAL ENGINEERING PLANT COST INDEX (CEPCI)

(1957–59 = 100)	Feb. '21 Prelim.	Jan. '21 Final	Feb. '20 Final
CE Index	637.9	616.5	595.2
Equipment	782.8	751.5	722.0
Heat exchangers & tanks	675.3	637.3	615.5
Process machinery	771.1	746.8	722.1
Pipe, valves & fittings	1052.6	1012.4	952.0
Process instruments	450.7	439.8	416.9
Pumps & compressors	1111.5	1103.4	1083.6
Electrical equipment	575.4	573.2	563.7
Structural supports & misc.	847.0	798.7	767.2
Construction labor	334.5	334.6	335.4
Buildings	653.5	635.0	590.7
Engineering & supervision	310.8	311.1	313.1

Annual Index:
2013 = 567.3
2014 = 576.1
2015 = 556.8
2016 = 541.7
2017 = 567.5
2018 = 603.1
2019 = 607.5
2020 = 596.2



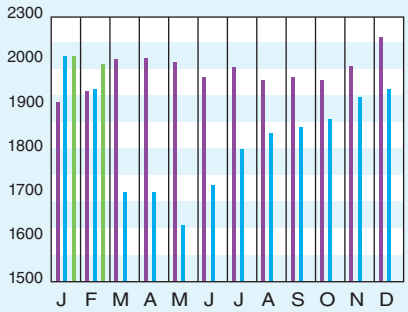
Starting in April 2007, several data series for labor and compressors were converted to accommodate series IDs discontinued by the U.S. Bureau of Labor Statistics (BLS). Starting in March 2018, the data series for chemical industry special machinery was replaced because the series was discontinued by BLS (see *Chem. Eng.*, April 2018, p. 76–77.)

CURRENT BUSINESS INDICATORS

	LATEST	PREVIOUS		YEAR AGO
CPI output index (2012 = 100)	Mar. '21 = 99.1	Feb. '21 = 100.6	Jan. '21 = 100.6	Mar. '20 = 100.0
CPI value of output, $ billions	Feb. '21 = 1,985.7	Jan. '21 = 1,952.1	Dec. '20 = 1,952.1	Feb. '20 = 1,987.5
CPI operating rate, %	Mar. '21 = 74.1	Feb. '21 = 75.2	Jan. '21 = 75.2	Mar. '20 = 74.5
Producer prices, industrial chemicals (1982 = 100)	Mar. '21 = 287.0	Feb. '21 = 235.3	Jan. '21 = 235.3	Mar. '20 = 237.9
Industrial Production in Manufacturing (2012 =100)*	Mar. '21 = 102.8	Feb. '21 = 102.6	Jan. '21 = 102.6	Mar. '20 = 99.6
Hourly earnings index, chemical & allied products (1992 = 100)	Mar. '21 = 192.9	Feb. '21 = 194.3	Jan. '21 = 194.3	Mar. '20 = 186.8
Productivity index, chemicals & allied products (1992 = 100)	Mar. '21 = 100.1	Feb. '21 = 104.4	Jan. '21 = 104.4	Mar. '20 = 101.2

CPI OUTPUT INDEX (2000 = 100)†

CPI OUTPUT VALUE ($ BILLIONS)



CPI OPERATING RATE (%)

*Due to discontinuance, the Index of Industrial Activity has been replaced by the Industrial Production in Manufacturing index from the U.S. Federal Reserve Board.
†For the current month's CPI output index values, the base year was changed from 2000 to 2012
Current business indicators provided by Global Insight, Inc., Lexington, Mass.

CURRENT TRENDS

The preliminary value for the *CE* Plant Cost Index (CEPCI; top) for February 2021 (the most recent available) indicates another large monthly rise, the fifth consecutive monthly increase. The large uptick in February seems to be tied largely to significant increases in producer prices for steel products, including carbon steel sheets, plates and bars. These increases resulted in higher values for the both the Equipment and Buildings subindices. The Construction Labor and Engineering & Supervision subindices actually both saw small decreases in February. The current CEPCI value now sits at 7.2% higher than the corresponding value from February 2020. The Current Business Indicators (middle) showed a small decline in the CPI Output Index for March.